Knowledge Transfer, Collaborative Innovation and Firm Performance: The case of University Science and Technology Parks

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ABSTRACT

University Science and Technology parks play a very important role in the national innovation system. They serve as a platform for universities to transfer and apply their scientific research outcomes to industry and help to incubate high-tech firms. The functions of University Science and Technology Park are mainly reflected in the following aspects: assisting the transformation of university research outcomes, serving business incubation, supporting personnel training, and strengthening industry-university cooperation. According to the knowledge-based theory, the ability to create and apply knowledge is the source of the firm's competitive advantage, and the stock of firm's knowledge is critical for the firm's development.

Given that firms in high-tech industries always face changes of resource constraints, only relying on internal knowledge and resources is not enough to support the long-term development of enterprises. Acquiring external knowledge has become one of the important ways for firms to improve their knowledge and capabilities. University Science and Technology parks are an effective mechanism through which knowledge is transferred from universities to firms, in turn, enhances the firm's value creation and performance. However, previous studies have shown that the efficiency of knowledge transfer in Chinese universities is only 39 %, far less than 60 % in developed countries. Therefore, the research on the mechanism of knowledge transfer has an important practical value.

Drawing on the knowledge-based theory and knowledge collaboration theory, this research develops a conceptual model to examine how external knowledge transfer can promote cooperative innovation and improve firm's performance. This research argues that the relationship between knowledge transfer and collaborative innovation is contingent on absorptive capacity while the relationship of collaborative innovation with firm performance is enhanced when the firm has strong entrepreneurial orientation. By using the sample of 268 firms from University Science and Technology Parks in China, I find that external knowledge has a significant positive impact on firm performance. Moreover, knowledge acquisition and knowledge sharing can improve the knowledge stock of firms, and then improve the growth and profitability of firms. Moreover, collaborative innovation activities promote firm performance, but different collaborative

innovation activities have different effects on firm performance. Exploratory collaborative innovation can improve the growth performance, and the impact of exploitative collaborative innovation on the profitability performance is more significant. Furthermore, external knowledge has a significant positive impact on collaborative innovation. Knowledge acquisition and knowledge sharing can effectively promote collaborative innovation activities. It also verifies that collaborative innovation mediates the relationship between external knowledge and firm performance. Exploratory collaborative innovation and exploitative collaborative innovation play a full mediating role in the relationship between knowledge sharing and firm growth performance such that knowledge sharing enhances collaborative innovation activities, in turn, improve enterprise performance. I also find that the four dimensions of absorptive capacity play a significant moderating role between external knowledge and collaborative innovation. Finally, entrepreneurial orientation plays a significant moderating role between collaborative innovation and firm performance.

This thesis studies the performance of university science park enterprises from the perspective of cooperative innovation. The research results can help enterprises improve corporate performance through knowledge transfer and provide guidance and reference for the development of University Science and Technology Parks.

Key words: The University Science Parks; Collaborative Innovation; Knowledge transfer; Firm's Performance

CONTENT

1 INTRODUCTION

1.1 Research Background

Since the trend of economic globalization came into being, technology, information and resources have been shared. Based on their own characteristics, each country actively seeks its own competitive advantage in the stage of globalization. With the deepening of globalization and increasing competition, innovation has become an important factor to measure a country's competitiveness, in which knowledge plays an increasingly important role. It has become a country's intellectual capital and promotes a country's economic development. Similarly, in the current era of knowledge economy, knowledge has become the first strategic resource for enterprise development. It has become the most critical input element and core asset of each enterprise, and it is an important source of building and maintaining enterprise innovation capabilities and core competitiveness (Park, 2011; Lyles & Salk, 1996). If an enterprise wants to gain a foothold in the fierce market environment, it must do its best to acquire, master and use knowledge to the greatest extent, so as to improve its core competitiveness and establish its own advantages. Generally, companies gather knowledge in two ways, one is internal development, and the other is external introduction. However, it is far from enough to rely on the knowledge obtained from the internal production and operation of enterprises for enterprise innovation. At the same time, enterprises need strong financial support to rely on their own internal knowledge development, which is also unrealistic for ordinary enterprises. Therefore, when enterprises gather knowledge to improve their competitiveness, they tend to introduce knowledge from suppliers, competitors, customers and partners (Mowery & Rosenberg, 1991; Camisón & Forés, 2011), and knowledge transfer occurs in the process of external introduction.

Colleges and universities are the main creators of knowledge, which provide new knowledge and advanced knowledge for the outside world (Agrawal, 2011). The collaborative innovation between universities and enterprises is one of the ways for enterprises to introduce external knowledge. The Bayh Dole act passed in 1980 in the United States has set off an upsurge of school enterprise cooperation, which promotes the development of American economy, and it has aroused the attention of scholars in the field of school enterprise knowledge transfer. In recent years, China has vigorously

promoted the development of collaborative innovation. In 2012, the Ministry of Education implemented a plan to encourage the establishment of collaborative innovation centers, promote in-depth cooperation between universities and research institutes, enterprises, and local governments, and help create an environment and atmosphere conducive to collaborative innovation of industry, university and research. In 2013, the Third Plenary Session of the 18th Central Committee of the Communist Party of China emphasized the establishment of a collaborative innovation mechanism for industry, academia and research, and measures to build a national innovation system. In 2015, the State Council promulgated the "Opinions on Several Policies and Measures for Vigorously Promoting Mass Entrepreneurship and Innovation", which quickly set off a climax of innovation and entrepreneurship for all people. Since then, collaborative innovation has become a new model for China to improve its independent innovation capabilities. At the same time, how to innovate and spread their knowledge, and how to carry out collaborative innovation with national and regional enterprises has also become a topic of concern in higher education. In the early 1990s, the Chinese government increased its scientific research funding input to universities year by year, and strongly encouraged universities to carry out research. While researching and developing, actively carry out knowledge transfer to enterprises, and strengthen the transformation of scientific and technological achievements of universities to enterprises. Knowledge flows from universities to enterprises, enterprises absorb the knowledge transferred by universities, and a new entity of university science and technology parks appears.

The birth of the university science and technology parks has become a link between enterprises and universities. On the one hand, the high-tech enterprises in the society are gathered in a range to form an innovative agglomeration effect and build an innovative project incubation platform; on the other hand, it can mobilize the innovative talents and knowledge resources of universities and effectively realize the transfer of knowledge and technology. In general, it provides channels for the transformation of innovation achievements in Colleges and Universities, and ultimately promotes the improvement of knowledge transfer performance of both sides. In the study of this thesis, the science and technology parks involved mainly come from Fujian Province, Guangdong Province, Zhejiang Province and other regions, the specific information of the science and technology parks is shown in Appendix 1.

The level of knowledge transfer performance directly affects the level of scientific research and personnel training of universities, as well as the innovation ability and market competitiveness of enterprises. Successful knowledge transfer promotes the rapid development of the regional economy and even the national economy, and plays a vital role in the formation and development of China's innovation system. However, due to the different original intentions of the establishment of enterprises and universities, although they are constantly pursuing innovative knowledge, differences in organizational culture, knowledge structure, and behavioral methods may cause obstacles to the cooperation between the two parties; at the same time, due to their respective Many contradictions are difficult to directly reconcile the differences in the understanding of innovative knowledge, resource ownership, utilization and allocation concepts, value judgments, and attitudes towards innovation risk, which will affect the effect of knowledge transfer. Fan et al (2015) found that the knowledge transfer efficiency of Chinese universities was 39% from 2005 to 2011, while the average knowledge transfer efficiency of developed countries was over 60%, which shows that the knowledge transfer level of Chinese universities is not high and still there is a lot of room for improvement.

In order to solve the problem of low performance of knowledge transfer in Chinese colleges and universities, it is necessary to understand the mechanism of knowledge transfer between schools and enterprises, and find the root causes of knowledge transfer between schools and enterprises. As a link between universities and enterprises, university science and technology parks are of typical significance for research. Therefore, this thesis focuses on how to improve the knowledge transfer performance of national university science parks under the collaborative innovation model, as well as the combined effects of corporate absorptive capacity and entrepreneurial orientation.

1.2 Research Significance

In the era of knowledge economy, economic globalization has intensified enterprise competition among countries. In the dynamic external environment, how to increase the knowledge stock of enterprises, improve the knowledge transfer performance of school-enterprise cooperation, and improve the innovation performance of enterprises has become an urgent need solved problem. This thesis attempts to use the structural equation model method, taking university science parks as the research object, discussing the path of knowledge transfer, and studying the impact of corporate absorptive capacity and self-

entrepreneurial orientation on performance, so that the research has more practical significance and operability. It is hoped that this study can provide a reference for the development of University Science Park.

(1) Theoretical significance

First, the construction and development of university science parks in China are not mature enough, and the research on university science parks is also in a relatively preliminary stage. Based on the development platform of the University Science Park, this thesis studies the knowledge transfer performance under the collaborative innovation mode of the University Science Park, and enriches the related research results of the University Science Parks.

Second, the integration of collaborative innovation and knowledge transfer performance promotes the development of knowledge collaboration theory to a certain extent. From the perspective of collaborative innovation, this thesis explores the factors that affect the performance of knowledge transfer in university science parks, and gives the relationship between various variables, which points out the direction for the improvement of knowledge transfer performance in university science parks. This thesis introduces the related research of collaborative innovation into the research field of knowledge transfer performance of University Science and Technology Park, and widens the research scope of knowledge transfer performance.

Thirdly, from an empirical perspective, it studies the influencing factors and paths of external knowledge of University Science and technology park enterprises on enterprise performance, and verifies the relevant assumptions among external knowledge, collaborative innovation, enterprise performance, absorptive capacity and entrepreneurial orientation, which provides theoretical guidance for the development of University Science and technology park enterprises.

(2) Practical significance

First, the construction and development of China's university science parks are still in the initial stage. In the process of building the national innovation system, university science parks are still facing various problems that need to be resolved. The Chinese government has put forward the economic development goal of promoting the optimization and upgrading of industrial structure and improving the ability of independent innovation. Among them, the collaborative innovation of University Science and technology park

enterprises is an important way and method to realize independent innovation, which can accelerate the adjustment of industrial structure and promote scientific development. This thesis introduces the related research of collaborative innovation into the research field of knowledge transfer performance of University Science and Technology Park, and widens the research scope of knowledge transfer performance.

Second, this study helps enterprises in the University Science and Technology Parks recognize the characteristics and advantages of knowledge transfer, accurately understand the knowledge transfer mechanism of enterprises under the collaborative innovation mode, promote enterprise employees to more actively participate in the process of knowledge transfer, carry out collaborative innovation activities with enterprises and universities in the park, and improve the knowledge transfer performance of enterprises and universities. It not only enables enterprises to obtain innovation ability, but also promotes the improvement of the overall strength of colleges and universities, helps enterprises obtain more landing scientific research achievements and enhance the social influence of colleges and universities. It provides reference for the University Science Parks in the promotion of Industry-university Research, as well as the implementation and transformation of intellectual property rights.

Third, this research explores the relationship between the external knowledge of university science parks, collaborative innovation and corporate performance from both theoretical and empirical aspects. It analyzes the path influence relationship between various variable factors, and can better understand. The role of each element provides a theoretical basis for adopting more effective measures to improve the performance of knowledge transfer in practice. The research results have solved the problem of low knowledge transfer performance of Chinese university science parks to a certain extent, and promoted university science parks. The healthy growth of the collaborative innovation center will further promote the long-term development of the regional economy and truly realize the joint sustainable development of collaborative innovation and the economy of the University Science Parks. It provides help and reference for relevant government institutions in the construction of collaborative innovation, knowledge transfer and entrepreneurship guidance.

1.3 Research Gaps

Through reading a large number of literatures related to knowledge transfer performance, it is found that scholars have conducted fruitful research on the factors affecting knowledge transfer performance, which provides inspiration and method reference for the research of this thesis. However, there are still some shortcomings in the existing research, which are mainly reflected in the following aspects.

First, although there are a lot of relevant researches on knowledge transfer at present, the research is mainly based on the knowledge transfer between multinational companies, enterprises in the same industry, and the internal departments of the same enterprise. There are still relatively few studies on knowledge transfer between schools and enterprises. Researches on knowledge transfer in university science parks are even more lackluster. However, as we all know, universities are an important source of knowledge for enterprises to innovate. At the same time, university science parks are also an important platform for school-enterprise exchanges. The research on knowledge transfer in gardens is very necessary.

Second, previous studies on the improvement of corporate performance by external knowledge have paid more attention to the direct relationship between the two, but there are relatively few studies on specific action paths and influence mechanisms. Researchers usually stand from the perspective of a static resource-based view. They believe that corporate performance is the direct output of a company after acquiring external resources. However, the knowledge obtained directly from the outside may not fully conform to the heterogeneous resources described by the resource-based audience. So how does the external knowledge that is not entirely heterogeneous resources improve corporate performance? How is this path achieved? Research on this aspect is still relatively small.

Third, although the external knowledge, collaborative innovation, corporate performance are several variables are more mature, but scholars have only studied the relationship of some of them, that is, the static study of pairwise. no research has been done to discuss these variables in the same framework. According to previous research and practical experience, there should be a certain relationship between external knowledge, collaborative innovation and enterprise performance. Therefore, based on the perspective of collaborative innovation, this thesis makes an empirical study on the transfer of

external knowledge in University Science and Technology Park, breaking the previous static research ideas.

1.4 Research Issues

This thesis takes university science parks as the research object, and discusses the influence mechanism of external knowledge transfer performance from the perspective of collaborative innovation. By consulting related literature, five related variables are extracted, which are external knowledge, collaborative innovation, corporate performance, absorptive capacity, and entrepreneurial orientation. Then thesis paper constructs a hypothetical model to conduct an empirical analysis of the impact of knowledge transfer performance. The main issues studied in this thesis are as follows:

First, the impact of external knowledge on corporate performance. Based on the knowledge-based theory, combined with the survey data of university science parks, the relationship between external knowledge and corporate performance is studied. In fact, there have been many studies on the relationship between external knowledge and corporate performance, and the positive relationship between the two has been extensively verified, and both theoretical and empirical studies are abundant. However, the division of external knowledge is not uniform, such as explicit knowledge, tacit knowledge, technology introduction, etc. There are also studies showing that the two are in an inverted U-shaped relationship. This thesis divides external knowledge into knowledge acquisition and knowledge sharing from the process of knowledge acquisition, and explores the impact of the two dimensions on corporate performance.

Second, what role does collaborative innovation play in the process of enterprise knowledge transfer? The source of corporate performance or corporate competitive advantage lies in the heterogeneous resources of the enterprise, and external knowledge does not completely conform to the characteristics of heterogeneous resources. Under the synergy of the governments of enterprises, universities, and research institutes, they can share resources and capabilities, complement each other's advantages, and grow together. Collaborative innovation is the only way for the development of current enterprises to maximize internal efficiency. At the same time, University Science and Technology Park provides convenience for enterprises and universities collaborative innovation. Therefore, taking University science and Technology Parks as the research subject, this thesis

discusses how enterprises transform external knowledge into enterprise performance through collaborative innovation.

Third, the role of absorptive capacity and entrepreneurial orientation in the process of corporate knowledge transfer. In previous studies, some scholars have shown that absorptive capacity as a mediator plays a role in the relationship between knowledge and performance. Some scholars believe that the strength of absorptive capacity regulates the relationship between knowledge and performance. Potential absorptive capacity and actual absorptive capacity play different roles in explicit knowledge and tacit knowledge. Studies have shown that there is a direct influence between entrepreneurial orientation and corporate performance. Here, entrepreneurial orientation is used as a moderating variable to explore whether different strengths of entrepreneurial orientation will affect the path of corporate knowledge transfer.

1.5 Research Methods

Because this research needs to study the relationship between multiple variables and the influence process between variables, it adopts literature research method, questionnaire survey method, in-depth interview method, statistical analysis method and other methods to conduct research to explain the relationship between each variable.

First, the literature research method. My research mainly retrieves documents related to research issues through databases such as CNKI, Web of Science, Baidu Academic, Google Scholar, ScienceDirect, etc., through reading and analyzing the documents, and combing and summarizing the research issues of this research. Literature research methods understand the research status and deficiencies of predecessors, conduct in-depth analysis of the problems to be studied, and construct research models. The entire process of research is inseparable from the support of previous studies.

Second, the questionnaire survey method. The data in this thesis comes from questionnaires. Through the research on the actual situation of university science parks, various variables that affect the knowledge transfer performance of university science parks under the collaborative innovation model are obtained. Based on the research content, the questionnaires are compiled based on the previous maturity scale, and then distribute the questionnaire to the target survey audience, and finally sort and analyze the recovered questionnaire to provide data support for further statistical analysis.

Third, the in-depth interview method. In the process of constructing theoretical models and designing measurement scales, this thesis not only based on existing literature, but also conducted in-depth exchanges with experts and scholars in related fields and internal staff of the University Science Park, and combined the suggestions of experts and scholars with the literature of the thesis. Combine research to improve the practicality of research questions.

Fourth, statistical analysis method. After obtaining valid data through questionnaire surveys, SPSS 22.0 and AMOS 24.0 software are used to analyze and process the data. The analysis methods adopted in this thesis include: correlation analysis, descriptive statistical analysis, reliability analysis, validity analysis, and model fit test, etc. By testing the hypothetical relationship between various variables, conclusions and recommendations are put forward.

1.6 Research Contribution

The research contributions of this thesis are embodied in the following points:

Firstly, through the theoretical analysis of external knowledge influencing enterprise performance, collaborative innovation is introduced into the theoretical framework, and a new path of knowledge transfer performance influencing mechanism of University Science and technology park is established. In the process of operation, the acquisition of knowledge from the outside and the sharing of knowledge in the collaborative network can promote the collaborative innovation activities of the enterprise, thereby improving the performance of the enterprise. The empirical study finds that exploratory collaborative innovation and exploitative collaborative innovation play a certain mediating role between external knowledge and enterprise performance. They open the "black box" between external knowledge and enterprise performance, enrich the knowledge transfer theory of University Science Park, and deepen the understanding of external knowledge. It provides a new way to study the relationship between external knowledge and enterprise performance. At the same time, it is concluded that external knowledge is an important antecedent of collaborative innovation, and external knowledge acquisition, knowledge sharing and collaborative innovation are the key antecedents of enterprise performance, which enriches the theory of enterprise knowledge transfer.

Second, it enriches the internal mechanism of external knowledge transfer in the collaborative innovation model from the perspective of dynamic capabilities. In previous

studies on the improvement of enterprise performance by external knowledge, researchers usually stand from the perspective of a static resource-based view and pay more attention to the direct relationship between the two. They believe that corporate performance is the direct output of the company after acquiring external resources, and not all external knowledge is heterogeneous resources. This thesis takes the enterprise collaborative innovation ability as the mediating variable. After obtaining external knowledge, the enterprise integrates external knowledge and internal knowledge through collaborative innovation activities, and turns them into heterogeneous resources with the characteristics of value, scarcity, hard to imitate, and hard to replace, so as to improve enterprise performance.

Thirdly, by analyzing the moderating role of absorptive capacity and entrepreneurial orientation in the path of knowledge transfer performance, the understanding of enterprise knowledge transfer process is expanded. This thesis takes university science and technology parks as the research object, broadens the application of knowledge transfer theory, studies and validates the influence mechanism of external knowledge on corporate performance, and provides a reference for university science and technology parks to efficiently allocate external knowledge to improve corporate performance. The thesis introduces entrepreneurial orientation as a moderating variable, and explores its moderating effect on corporate collaborative innovation and corporate performance. It gives three dimensions of entrepreneurial orientation, namely, innovation, risk-taking, proactive. It is considered as a decision-making concept and model adopted by enterprises to achieve their goals, create and maintain their competitive advantages, and reflects the decision tendency of enterprises in the process of operation. Entrepreneurship orientation can be applied to various organizations and can guide enterprises in strategic selection, implementation and formulation. With the same resources and capabilities, after adopting different entrepreneurial orientations, the performance will be different. It will affect the investment ratio of exploratory collaborative innovation activities and exploitative collaborative innovation activities, thus affecting the performance of enterprises.

1.7 Research Framework

Firstly, this thesis studies the characteristics and development status of university science parks through literature reading, sorts out the relevant theories of knowledge transfer, sorts out the factors that affect the performance of knowledge transfer, and summarizes

them. Secondly, the model of the influence mechanism of knowledge transfer performance in University Science and technology park is outlined. Then, through the questionnaire and structural equation model to verify the hypothesis, the empirical results are analyzed and discussed, and the enlightenment of the research results for empirical aspects is summarized. Finally, the thesis gives the conclusions, limitations and shortcomings of the research, and makes prospects for future research. The specific research framework is shown as in Figure 1-1.

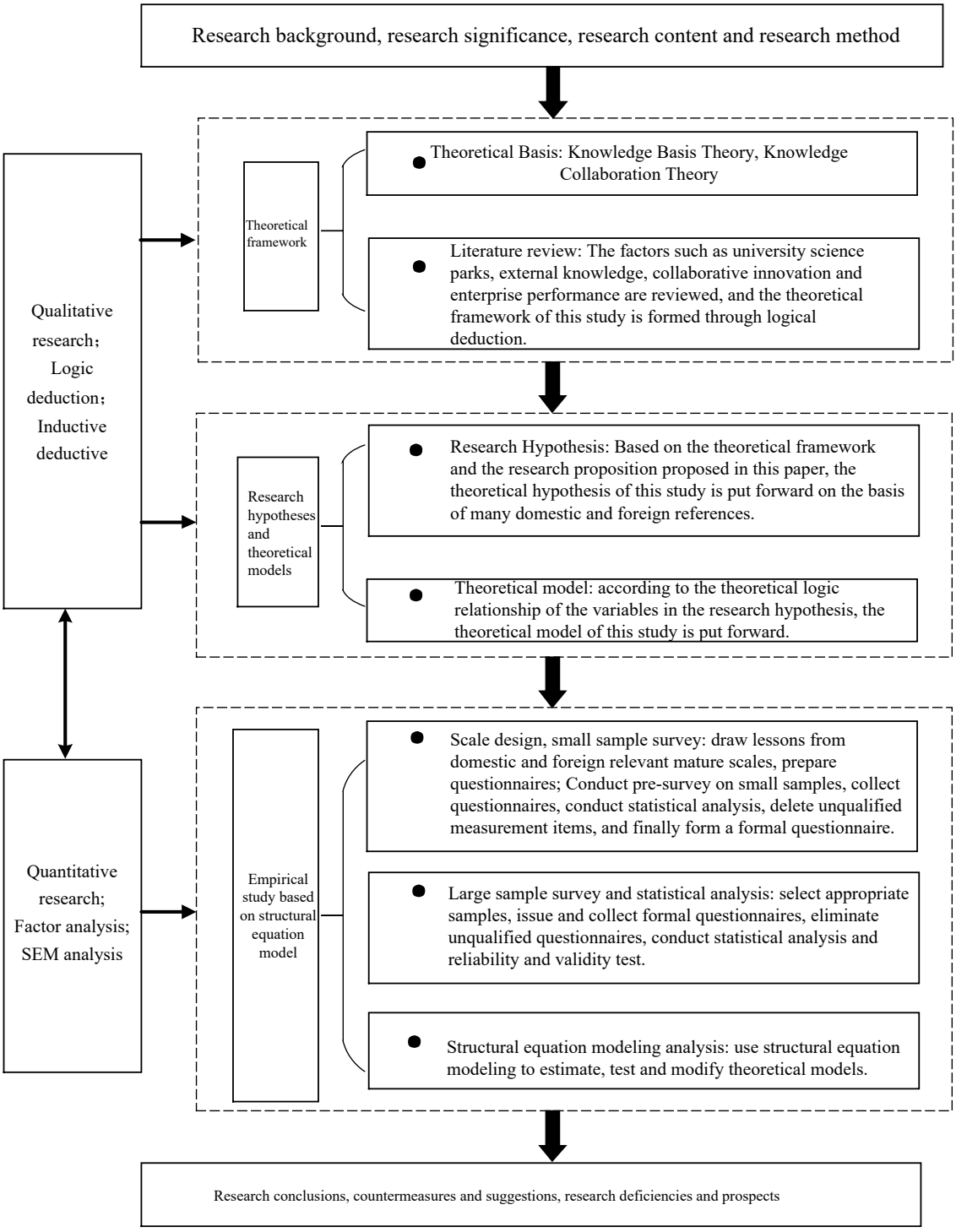

Figure 1-1 The research framework

The theoretical structure of this thesis follows the thinking process of problem formulation, problem modeling, problem solving and application. The specific research content is as follows:

Chapter one, introduction. This thesis introduces the research background and significance of this thesis, analyzes the importance of studying the performance of knowledge transfer in university science and technology park, and determines the content arrangement, research methods and ideas of the subsequent chapters on the basis of background research.

The second chapter, theoretical basis and literature review. On the basis of studying the existing literature, this thesis combs the university science and technology park, external knowledge, collaborative innovation and knowledge transfer performance, which lays a theoretical foundation for the subsequent research.

The third chapter, model construction and research hypothesis. On the basis of the research on the performance of knowledge transfer in university science and technology park, this thesis constructs a theoretical model of knowledge transfer performance in university science and technology park under the mode of collaborative innovation. On the basis of combing the literature and theory, it is assumed that knowledge transfer has an impact on enterprise performance through collaborative innovation, as well as the moderating role of enterprise and entrepreneurship orientation.

The fourth chapter, research and design. On the basis of the same or similar measurement scale, the external knowledge, collaborative innovation, entrepreneurship orientation, absorptive capacity, knowledge transfer performance measurement scale suitable for this study was constructed to form a questionnaire. First, small sample pre-study was carried out to analyze the reliability and validity of the recovered data. According to the results, the questionnaire items were modified appropriately to form a formal questionnaire.

The fifth chapter, empirical research. Taking the University Science and Technology Park as the main object of investigation, it mainly through issuing questionnaires and assisting in collecting data in the form of a small number of interviews. After the data collection is completed, the structural equation model is used to analyze the data. Verify that the assumptions between variables hold.

The sixth chapter, the result discussion. This thesis probes into the results of empirical research, analyzes the causes of the results, and puts forward relevant suggestions for the development of university science and technology park according to the research results.

Chapter VII, summary and prospect. This thesis makes a general summary of the full text, clarifies the main conclusions of this study, puts forward the shortcomings of this study, and makes a prospect for further research in the future.

2 THEORETICAL BASIS AND LITERATURE REVIEW

2.1 Relevant Theoretical Foundations

2.1.1 Knowledge-based Theory

With the rapid development of information technology, the economic industry represented by the Internet continues to grow at a high speed. The rapid expansion of technology companies such as Huawei has truly demonstrated the development and business model of enterprises that use knowledge and information as production factors for production and creation. With the advent of the era of knowledge economy, more and more scholars begin to pay attention to the important role of knowledge in the core competitiveness, innovation ability and performance of enterprises. Knowledge management is an important part of strategic management. It is a key task for enterprise managers to manage and protect valuable knowledge and ability. Through the effective use of enterprise knowledge into the innovation ability of enterprises in the market, enterprises can obtain and maintain competitive advantage and promote innovation performance. The knowledge-based theory is an application and extension of resource-based theory under the background of knowledge economy era, which absorbs the viewpoint and content of part of resource base view. The main point of view of resource base is that the reason why an enterprise can have competitive advantage in market competition is that it has special, scarce, high-value and unrepeatable resources (Barney,1991). Teece (1999) extended this theory to a dynamic process by viewing the firm as a dynamic capability generator, the firm adapts to the external changing environment through the dynamic capability, and these views are known as the knowledge-based view. Knowledge is widely regarded as an important resource for enterprise development, and the most critical reason for enterprises to maintain competitive advantage in the market competition is the knowledge they possess, and the amount of knowledge stock is the key to determine the high or low performance of enterprises. In an increasingly turbulent and complex technological and market environment, knowledge that is unique, path-dependent, non-exchangeable and difficult to imitate, as well as the ability to create and apply knowledge, is the source of lasting competitive advantage for organizations. But knowledge is an important exclusive

resource that is often costly and difficult to learn (Grant, 1996). At the same time, with the continuous development and growth of the enterprise, the knowledge accumulated within the enterprise is far from enough to support the long-term development of the enterprise. Enterprises can enhance their core competitiveness by keeping diffusible knowledge from spreading, continuously accumulating knowledge and continuously enriching the knowledge base by colliding old and new knowledge with internal and external knowledge within the enterprise (Barney, 1991). The processing of knowledge by firms includes knowledge creation, knowledge integration and knowledge transfer (Grant, 1996). Knowledge creation is the process of acquiring and organizing internal knowledge and required knowledge to create new valuable knowledge (Zhan et al., 2006), knowledge integration is the process of integrating internal knowledge and externally acquired knowledge into expertise required for enterprise operation, and knowledge transfer is the process of transferring knowledge from one organization to another. (Mark et al., 2008). Knowledge transfer occurs in the process of the enterprise drawing external knowledge, so the enterprise's attention to knowledge resources also determines to pay attention to the process of knowledge transfer.

2.1.2 Knowledge collaboration theory

The concept of knowledge collaboration (KC) is put forward first by Karlenzig. From the perspective of organizational strategy, he thinks that knowledge collaboration regulates all stakeholders through the dynamic integration of resources inside and outside the organization, and finally helps enterprises to maximize their benefits. Karlenzig (2002) put forward that the meaning of knowledge synergy is mainly reflected in two aspects. Firstly, knowledge synergy can effectively exchange and integrate various resources. Secondly, the purpose of knowledge synergy is to improve organizational performance, and then improve the overall competitiveness of the organization. After that, more and more scholars study knowledge synergy. They understand knowledge synergy from different angles, which makes people's understanding of knowledge synergy more comprehensive and profound.

Some scholars view knowledge collaboration from the perspective of process theory. For example, Anklam (2002) proposed that the advent of the knowledge economy has brought about the development of knowledge management, and the development of the first stage of knowledge management focuses on explicit knowledge. Knowledge collaboration

focuses on collaboration and cooperation. Through the collaborative interaction process, the overall collaboration between the two parties is realized. In the same year, Leijen (2002) proposed that knowledge collaboration is simply a process of cooperation between the two sides. Dealing with a problem requires various abilities. When I lack knowledge or ability in aspect a, you happen to have this ability and lack ability in aspect B, we will cooperate with each other and reach a consensus to integrate knowledge in aspect a and B to deal with the problem together. Some scholars define knowledge coordination from the perspective of activity theory, and they emphasize the flow of knowledge. Tong (2012) pointed out in his research that knowledge subject, knowledge object and environment are mutually coordinated, and knowledge subject transfers knowledge to appropriate and appropriate object, so that knowledge innovation and dynamic flow process is knowledge coordination. Yang et al. (2016) proposed that knowledge collaboration can be divided into two main activities. One part is that the knowledge subject first analyzes knowledge, then excavates knowledge, and then reconstructs and integrates knowledge to innovate based on the understanding of knowledge. The other part is to express and explain the above knowledge to make knowledge emerge, and then construct knowledge to realize the collaborative creation of new knowledge. They believe that knowledge collaboration involves multiple collaborative agents, and knowledge collaboration is the six knowledge activities experienced by these agents, which including knowledge sharing, knowledge transfer, knowledge acquisition, knowledge integration, application and innovation. There are also some scholars who view knowledge synergy from the perspective of synergy theory, which means that they believe that the overall benefit of the main body of knowledge synergy should exceed the sum of the benefits of all parts. For example, Xu (2015) pointed out that the ultimate that the ultimate goal of knowledge synergy is innovation. It is an interactive process based on knowledge management and synergetic theory and involving multiple subjects. It is an effective management model and main strategic means to integrate resources and improve organizational performance.

Although the specific concepts of knowledge collaboration are different, scholars agree that knowledge collaboration includes four elements, knowledge subject, object, time and environment. The subject of knowledge refers to the organization and individual participating in knowledge activities, and the object is the knowledge itself. The participants of knowledge activities share and cooperate knowledge under the background

of current time and environment, and jointly realize the improvement of performance. Knowledge collaboration pursues an effect of 'one plus one greater than two'. At the same time, knowledge collaboration is dynamic and will change over time. Knowledge collaboration includes the process of knowledge search, knowledge acquisition, knowledge transfer and knowledge innovation. Through the transfer of knowledge, both sides can achieve a win-win situation and achieve collaborative innovation.

2.2 Literature Review of Relevant Research

2.2.1 Literature Review of the University Science and Technology Park

(1) Connotation of University Science Park

University Science and Technology parks is produced in the background of fierce competition in international innovation and technology, and various countries encourage innovation. Silicon Valley first put forward the concept of science and technology park. The United States calls it Research Park, Japan and Canada call it "Technopark", Germany calls it Technologic Fabric, France calls it Technopole, China and the United Kingdom are collectively referred to as Science Park. At present, the name of University Science and technology park has not been unified all over the world, but it is regarded as the link of universities, enterprise and society, emphasizing the applicability of its transformation of scientific and technological achievements and value.

In 1986, the first annual meeting of the International Science Park was held, at which the University Science Park was defined as having planned or built buildings in a given area dedicated to scientific research and established cooperative relationships or links with universities. The partnership between universities and enterprises can develop risk industries and develop economy, and promote the transfer of scientific and technological achievements and the marketization of products between universities and enterprises. In 2010, the Ministry of Science and Technology of China and the Ministry of Education recognized that the University Science Park is an institution that provides services for technological innovation and the transformation of scientific research results. It relies on research universities or university clusters to integrate universities such as talents, technology, laboratory equipment, books, and other social resource advantages. From the definition of university science and technology park, it is not only the base of technological innovation, the incubating base of high-tech industry, but also the base of

talent gathering and application, as well as the demonstration base of cooperation between industry, university and research. From the definition of University Science and technology park, there are three common points. First, it emphasizes that the enterprises and universities in the University Science and technology park have established a formal cooperative relationship; Second, University Science and technology park has multiple functional advantages; Third, promoting the economic development in the region is the ultimate goal of establishing the University Science Park.

The University Science Park is a spatial form that strengthens the connection between universities and enterprises, and it is a knowledge-intensive base. Through the transfer and application of knowledge, enterprises in the park constantly realize knowledge innovation to obtain their own competitive advantage. In order to obtain the best interests and comprehensive advantages, the universities and enterprises in the park combine their resources to establish a cooperative relationship that complements each other's advantages, shares benefits, and develops together. It not only can solve the problems faced by enterprises, but also can effectively promote economic development. As a key component in the process of building an innovation system in China, the University Science and Technology Park introduces the knowledge resources and innovation resources of universities into the market economy, transforms the innovation knowledge of universities into economic benefits, and realizes the goal of transforming innovation achievements. The establishment of University Science and technology park is conducive to transferring knowledge from colleges and universities to enterprises and applying it to value creation, which makes the knowledge application of enterprises and knowledge creation of colleges and universities into a virtuous circle. It can not only realize the integration of knowledge economy, but also open up an effective way for enterprises to provide comprehensive competitiveness.

(2) The current situation of University Science and Technology Park

The research of University Science and Technology Park began in the early 1980s, which can be divided into the following topics. The first is to study the influencing factors of the development of science and technology parks. By studying the reasons for the success of Silicon Valley, the researchers come to some factors that affect the development of science and technology parks, such as tolerating failure, encouraging risk-taking, and accumulating knowledge (Mcadam et al., 2005). The second is the research on the internal

organization system of science and technology park, and the third is to explore the different stages of the development of science and technology park (Dettwiler et al., 2006). Overall, it is based on the development of science and technology park. China's research on science and technology parks began in the 1990s. In 1995, a symposium on the work of the University Science and Technology Park was held in Beijing, and the development of the University Science and Technology Parks began to receive attention. China's research on science and technology parks is mainly conducted from the aspects of the management system in the science park and the role of the science park.

In the research on innovation efficiency of university science parks, scholars have conducted research mainly from three aspects: efficiency measurement methods, differences in innovation efficiency in different regions, and factors affecting innovation efficiency. In terms of efficiency measurement methods, scholars have adopted the Malmquist index (Chen et al., 2006; Sun, 2011), the DEMATEL method (Lin et al., 2009), and the data envelopment analysis method (Liu, 2009) to measure the efficiency of science and technology parks. In terms of innovation efficiency differences, Zheng (2010) selected the R & D investment, the number of enterprises in the park and the number of patents in the park as indicators to measure the innovation efficiency of science and technology parks. He also compared the performance of science and Technology Parks in eastern, central and western regions. The study found that the development of Western parks was the worst, while that of Eastern parks was better. Qian (2011) used DEA method to study the issue. His research results also showed that the development of science and Technology Park of Western University has a great gap with the East, and the development level of Chinese University Science and technology park is low as a whole. However, Wu et al. (2012) came to different conclusions. They used the data of 33 National University Science and Technology Parks from 2006 to 2009 to measure the performance by using data envelopment analysis and Malmquist index, and found that the overall efficiency of the parks was not high, but there was no obvious difference in the development of National University Science and Technology Parks in different regions. The efficiency of the eastern local science and technology park is not different from that of the central and western regions. In terms of factors affecting innovation performance, scholars have also discussed from different perspectives. Tian (2015) believed that university science and technology parks play a role in technology transfer,

and talents, science and technology park systems and models will have an impact on technology transfer. Gao et al. (2019) believed that the influencing factors of the development of National University Science and Technology Park include the investment of people and property, regional environment and University attributes, and put forward corresponding countermeasures and suggestions from the perspective of regional innovation, industrial structure and unbalanced regional development. In general, the process from university knowledge creation to knowledge internalization in enterprises and transfer performance can be regarded as the operation of ecological community based on knowledge metabolites, which is similar to the circular system in the generalized ecological community theory (Dai, 2013). In order to have the ability of sustainable development, the most basic requirement is to have a complete cycle system and be able to smoothly realize the exchange of material and energy between various links, and maintain the dynamic balance of the cycle system (Yang et al., 2017), Therefore, the university science park needs to pay attention to the openness and connectivity of school-enterprise cooperation, effectively allocate resources, and effectively handle the relationship between universities, enterprises, and governments to realize the sustainable development of the University Science Parks.

2.2.2 Literature Review of External Knowledge

(1) Connotation of external knowledge

In strategic management research, knowledge is defined as experience, know-how, foresight, information or ability (Dixon, 2000), knowledge is inseparable in the process of creating value for the company (Grant, 1996; Wiklund et al., 2003). Studies have shown that external knowledge accounts for 30% of the various types of knowledge that enterprises need to integrate in innovation (Rothwell, 1992). The most common classification of knowledge is based on the difficulty of knowledge transfer, which can be divided into explicit knowledge and tacit knowledge. Tacit knowledge is scarcer and more difficult to obtain, and it can often bring higher value to the research and development of enterprises (Grant, 1997). As the resource of knowledge plays a very important role in enterprises, scholars have done a lot of research on external knowledge acquisition, and many scholars have defined the behavior of external knowledge acquisition. Han (2015) believed that knowledge acquisition is the transformation of knowledge from the outside of the organization into internal knowledge. At the same time,

the enterprise needs to organize this knowledge to make it the knowledge needed for organizational innovation. External knowledge constrains the knowledge source, which needs to be outside the organization and beyond the enterprise boundary, and it is rather than the knowledge generated inside the enterprise.

Zhou et al. (2005) believe that external knowledge refers to new knowledge acquired from external relationships such as customers, suppliers, competitors and partners. Some scholars believe that in addition to the above sources of acquiring new knowledge, companies can also acquire knowledge through technology partners, especially cooperation with scientific research institutions (Fabrizio, 2007; Tardivo et al., 2017). In summary, it can be seen that although there are subtle differences in the definition of external knowledge, the essence is the same, and it is emphasized that enterprises should be good at using the external relations of the organization to obtain knowledge resources.

In the understanding of knowledge transfer, scholars from different disciplines have different understanding. Based on the perspective of knowledge utilization, Szulanski (1996) proposed the communication mode between knowledge source and knowledge receiver, and believed that knowledge transfer was purposeful and planned. Argote et al. (2000) proposed that the purpose of knowledge transfer will enhance the efficiency and effect of knowledge transfer. Davenport (1997) defined the process of knowledge transfer, which includes two processes: the transmission of one subject knowledge and the absorption of another subject knowledge. Ma (2006) believed that knowledge transfer cannot be limited to the process of knowledge transfer. The key is that the receiver needs to transform it into its own through learning and integration and apply it to its own operations and R&D activities. From the perspective of learning theory, organizational learning refers to the enterprise to acquire knowledge, disseminate knowledge and apply it to the development of organization. It can help enterprises realize innovation and growth, including knowledge acquisition, dissemination, sharing and application. Among them, knowledge sharing refers to the transfer of knowledge among organization members through communication, and external knowledge acquisition refers to the process of acquiring new knowledge from customers, suppliers, competitors and various partners through learning.

(2) Current status of external knowledge research

In the study of external knowledge, some scholars have conducted research on the relationship between external knowledge acquisition and innovation performance. Their research conclusions show that external knowledge acquisition is conducive to corporate innovation performance. In addition to using their own scarce knowledge resources, companies also need to use inter-organizational learning and cooperation to obtain knowledge from the outside. Studies have shown that among the various types of knowledge that enterprises need to integrate for innovation, the knowledge acquired outside the enterprise accounts for 30% (Rothwell, 1992). In the related research of external knowledge acquisition, some scholars will study it as a whole, and some scholars will distinguish the impact of different knowledge sources on enterprise innovation performance.

In the measurement research of external knowledge acquisition, most of them are measured from the knowledge source and acquisition intensity. Escribano et al. (2009) used seven sources of knowledge to measure external knowledge flows, which including customers, suppliers, competitors, universities, research institutions, professional journals and conferences. Tsang (2002) studied knowledge acquisition of international joint ventures from three aspects: technology and qualification acquisition, management and business development. He used a nine-item measurement scale. When measuring market knowledge acquisition, Zhou et al. (2012) used the amount and degree of knowledge acquired by external partners as the measurement standard, which including three items that the company has ways to continuously collect information from customers, competitors, and distributors. When measuring the breadth of knowledge search, Laursen et al. (2006) mainly examined the number of external knowledge sources, and divided them into four parts: market, institution, specialization standards, and other four parts. They set 16 knowledge sources and scores, with the lowest score. 0, representing a completely closed innovation model without external knowledge acquisition; the highest score of 16, representing a completely open innovation model, with the highest degree of external knowledge acquisition. Wu (2013) has studied local knowledge search and international knowledge search, and his measurement method still adopts the information source type. He has selected five information sources, which are establishing contacts with customers, suppliers, distributors, research institutions and innovation intermediaries, and supervising and collecting innovation information of

competitors. In general, the measurement methods of external knowledge acquisition are very concentrated, basically based on the number of knowledge sources and the degree of acquisition.

In the research on the relationship between external knowledge and corporate performance, some scholars have found that the acquisition of external knowledge is beneficial to corporate innovation performance. Ahuja et al. (2001) studied the innovation performance of acquired enterprises in chemical industry. Through empirical test, it is found that the absolute scale of knowledge base obtained in technology acquisition promotes innovation performance, but the relative scale reduces innovation performance, and non-technical acquisition has no significant impact on innovation performance. Jordan et al. (2010) interviewed 94 software project managers and found that the external knowledge acquired by enterprises through strengthening the connection with external knowledge subjects and resources can improve the level of project innovation. Zhu et al., (2008) studied the impact of different ways of knowledge acquisition on technological innovation of Chinese enterprises. They found that acquisition of external knowledge through direct means such as purchase and information collection has less impact on technological innovation, while cooperation and talent introduction have significant impact. Their research further confirms the importance of tacit knowledge acquisition, and points out that in cooperation with scientific research institutions, large enterprises can benefit from it, while small enterprises should tend to have targeted project cooperation. Frenz et al. (2009) divide the company's external source knowledge into purchasing technology and cooperative R & D. their research shows that purchasing technology can promote the company's innovation performance, while cooperative R & D has no significant effect on innovation performance. Li et al. (2014) used panel data to study the search of technical knowledge of Chinese enterprises. Unlike the technology search of developed countries, Chinese enterprises obtained better technological innovation performance when searching familiar with technology than the results of new technology search. The reason is that Chinese enterprises are constrained by resources and short-term strategic objectives, and tend to imitate innovation. Due to historical reasons and path dependence, the internal R & D capacity of Chinese enterprises is limited (Li et al .2014). In the research on external knowledge, some have discussed external knowledge as a mediating variable, but the positive relationship between it and innovation

performance can also be revealed. Some studies have shown that there is not a simple positive correlation between external knowledge and enterprise performance. Laursen et al. (2006) studied the relationship between external search strategy and innovation performance. The empirical results show that the depth and breadth of knowledge search have an inverted U-shaped relationship with innovation performance, which is not conducive to enterprise innovation performance in the case of excessive search. Roper et al. (2017) divide external knowledge acquisition into interactive and non-interactive categories. Although both have a positive effect on the innovation performance of enterprises, interactive knowledge acquisition can produce good externalities through knowledge spillover effects. However, non-interactive knowledge acquisition will generate negative externalities through competitive effects, which inhibits company-level innovation.

With the continuous deepening of research, scholars have refined the study of external knowledge acquisition, and they have studied its impact on enterprise innovation from the perspective of knowledge dimensions and acquisition methods. At the same time, it fully discussed the moderating variables that affect the strength of the relationship between the two. Absorptive capacity is one of the important moderating variables. Knowledge sharing is the process of mutual understanding and absorbing each other's new knowledge among enterprise members or between enterprises and partners. Through knowledge sharing, only collisions and the generation of new ideas are realized, which is conducive to the realization of innovation by enterprises. In the study of knowledge sharing and innovation performance, Nonaka (1994) pointed out that knowledge sharing strengthens the mutual transformation between tacit knowledge and explicit knowledge, and promotes enterprise innovation. Wang etc. (2014) divided knowledge sharing into explicit knowledge sharing and tacit knowledge sharing. Based on knowledge-based theory and intellectual capital theory, empirical research concluded that both explicit knowledge sharing and tacit knowledge sharing have positive effects on corporate performance. It has an impact, but the direct impact is not significant. Intellectual capital plays a completely mediating effect between knowledge sharing and corporate performance. Sun et al. (2019) explored the relationship between knowledge sharing and corporate performance based on the survey data of small and micro enterprises. Based on social network theory and knowledge management theory, they constructed a relationship

model for small and micro enterprise relationship strength, knowledge sharing, and corporate performance. The research concludes that knowledge sharing plays an mediating effect between the strength of corporate relationship and corporate performance. Although it is exploring the mediating effect of knowledge sharing, it also illustrates the impact of knowledge sharing on corporate performance. Their research also points out that absorptive capacity plays a moderating role between knowledge sharing and firm performance. Potential absorptive capacity positively moderates the relationship between implicit knowledge sharing and firm performance, indicating that absorptive capacity positively moderates the relationship between explicit knowledge sharing and firm performance.

To sum up, the role of knowledge acquisition and knowledge sharing on enterprise innovation performance has been widely recognized by the academic community, and the research has also been carried out in more detailed and in-depth aspects, such as the impact of different dimensions of knowledge, knowledge acquisition channels, pertinence and extensiveness of knowledge acquisition on innovation.

2.2.3 Literature Review of Collaborative Innovation

(1) Connotation of collaborative innovation

Chen (2011) believed that collaborative innovation is knowledge production organizations (i.e., universities, scientific research institutes, etc.) and enterprises cross organizational boundaries and share their own advantageous resources and capabilities under the collaborative cooperation between the government and relevant intermediary service organizations. Chen et al. (2012) further studied the theory of collaborative innovation, and proposed that collaborative innovation is the unimpeded transfer and sharing of innovation elements between systems, and realizes the value-added knowledge of 1+1+1>3 when the common goal is achieved. Zhong et al (2012) believed that collaborative innovation is due to the uncertain market environment and scarce innovation resources that prompt enterprises to collaborate and reintegrate technological innovation capabilities. Yu et al. (2014) proposed in the study that collaborative innovation means that multi-party organizations such as enterprises, universities, and governments break the barriers of time and space, and effectively gather the basic elements of high-tech innovation and entrepreneurship such as human, material, and financial resources to improve the efficiency of industrial innovation. Zhang (2016)

believed that the motivation of synergy is the reduction of interactive innovation costs, the advancement of R&D technology and the increase of self-interest. Chu (2017) believed that the limitation of professional knowledge will affect the motivation and efficiency of employee organizations to absorb other professional knowledge, and the knowledge sharing, transfer and creation of collaborative innovation network can quickly improve the learning efficiency of enterprises and enhance the innovation ability of enterprises. Based on the definition of collaborative innovation in the existing research, this study believes that collaborative innovation is an innovation activity in which all subjects break through all kinds of difficulties, reach an agreement on the content of cooperation in terms of strategy and organization, realize the effective transfer of knowledge and technology, work together to achieve the goal, and increase the overall efficiency.

(2) Current status of collaborative innovation research

Based on the survey data of 188 small and medium-sized manufacturing enterprises, Xie (2010) used structural equation model to explore the relationship between different collaborative innovation networks and enterprise innovation performance. The results show that the collaborative innovation network between enterprises and enterprises, intermediaries, research organizations have a significant positive effect on enterprise innovation performance, while the "enterprise-government" collaborative innovation network has no direct effect on enterprise innovation performance, but it has a significant indirect effect. This study confirms that there are significant differences in the impact of different collaborative innovation networks on enterprise innovation performance. After that, Xie et al. (2013) summarized the relevant research on enterprise innovation culture, took R & D intensity as the control variable, analyzed the impact of four elements of enterprise collaborative innovation culture (knowledge sharing, organizational innovation climate, collaborative decision-making, organizational change) on innovation performance, and explored the moderating role of team cohesion in the relationship between collaborative innovation culture and innovation performance. Based on the questionnaire survey data of 110 manufacturing enterprises, they conducted an empirical study through the hierarchical regression method. The results show that the four elements of collaborative innovation culture, knowledge sharing, organizational innovation climate, collaborative decision-making and organizational change have a significant positive

impact on innovation performance. In addition, team cohesion moderates the relationship between collaborative innovation culture and innovation performance. The conclusions make up for the deficiencies of the existing research, and provide guidance and reference for the improvement of innovation performance of Chinese manufacturing enterprises.

Based on the theory of knowledge management and innovation capability, Wang et al. (2013) revealed the mechanism of collaborative innovation process by studying the complex relationship between the key factors affecting enterprise innovation performance in supply chain network. They used hierarchical multiple regression (MR) and harmonic multiple regression (MMR) to investigate 236 Chinese companies. The results show that there is a significant positive correlation between collaborative innovation activities, knowledge sharing, collaborative innovation capability and enterprise innovation performance. In addition, they also found that knowledge sharing plays a partial mediating role in the relationship between collaborative innovation activities and enterprise innovation performance. Collaborative innovation ability has a moderating effect on the relationship between collaborative innovation activities and innovation performance.

2.2.4 Literature Review of Absorptive Capacity

(1) Connotation of absorptive capacity

Cohen et al. (1990) defined absorptive capacity as the ability to recognize the value of external new information and to digest and apply it. They believed that absorptive capacity is dependent on past knowledge and is a "subsidiary product" of the company's R&D investment, which represents the company's current level of knowledge in a certain field. Although Cohen et al (1990) didn’t clearly point out the dimensions of absorptive capacity, the definition and analysis they gave should include at least three types: value judgment ability, digestion ability and application ability. Since then, some scholars believe that the above explanation of absorptive capacity is not only concise and easy to understand, but also well explains its real connotation (Todorova et al., 2007). Some scholars believed that its definition still needs to be improved, and continue to develop its connotation. They believed that the former definition takes too much into account the situation of absorbing enterprises and ignores the factor of the learned (knowledge source), because the process of forming an organization's absorptive capacity is actually the process of learning from another organization. Therefore, absorptive capacity should be

a dyad-level structure capacity, which is closely related to the learning organization. Zahra et al., (2002) redefined the absorptive capacity on the basis of previous studies, and thought that the absorptive capacity contains rich meanings, and should be classified as the category of dynamic capability of enterprises, which is an important factor to maintain the competitiveness of enterprises. They think absorptive ability is a series of rules and procedures for enterprises to absorb, digest, transform and apply knowledge to generate dynamic capability. Based on the theory of dynamic capability, the four dimensions of absorptive capacity are redefined: acquire, assimilate, transform and application. Their greatest contribution is to sum up the four dimensions of creativity into potential capability and realistic capability. The research results break through the strict boundary between absorptive capability and dynamic capability, and reveal the essence that absorptive capability of enterprises can adapt to the rapidly changing market by re-allocating knowledge.

(2) Current status of absorptive capacity research

Jansen et al. (2005) explored how organizational antecedents affect potential and realized absorptive capacity, and identified the different effects of the two components of absorptive capacity. The results show that the organizational mechanism related to coordination ability mainly enhances the potential absorptive capacity of the unit. The organizational mechanism related to socialization ability mainly increases the absorptive capacity of the unit. The results reveal why units may be difficult to manage potential levels and achieve absorptive capacity, and their ability to create value from absorptive capacity varies. The research of Winkelbach et al. (2015) shows the internal relationship between complexity and absorptive capacity and value creation. Contrary to expectation, prior knowledge has no significant effect on value creation itself. On the contrary, the impact of complex technical knowledge on value creation is improved at a high level of prior knowledge and absorptive capacity. The results show that following the old path will lead to the capability trap, and the knowledge related learning ability enables the company to deal with the dynamic environment.

The research of Ubeda et al. (2018) shows that the location effect of all enterprises is not uniform. Considering that the absorptive capacity of companies is a moderating variable, their model considers the nonlinear relationship between science and Technology Park and innovation performance. They created a panel dataset of companies located inside

and outside the park and identified three main effects. The absorptive capacity of catching up companies is low, and their position in the science and Technology Park does not improve their innovation performance. Catch up companies have medium absorptive capacity and form a group that can benefit more from their presence in science and technology parks. The former boundary sharing company has a higher absorptive capacity, but the dual nature of knowledge reduces the impact of science and Technology Park on its innovation performance.

Distel (2019) explored the multi-level antecedents of absorptive capacity using survey data collected from 342 informants from 106 medical technology companies at different levels. Multilevel structural equation model analysis shows that the formal and informal integration mechanisms are positively related to the absorptive capacity at the organizational level, and this relationship is regulated by the micro level process. The results show that the cognitive process and creative behavior of knowledge work perspective are the important micro basis of absorptive capacity. In addition, the results emphasize the key role of key employees in explaining the heterogeneity of organizational capacity building at the company level.

Sun et al. (2019) based on the survey data of China's small and micro enterprises, used confirmatory factor analysis and multiple hierarchical regression methods to explore the relationship between relationship strength and innovation performance. It is found that the strong relationship promotes the improvement of innovation performance, while the weak relationship inhibits the improvement of innovation performance; Tacit knowledge sharing completely mediates the promotion effect of strong relationship on innovation performance. Explicit knowledge sharing partly mediates the promotion effect of strong relationship on innovation performance, but slows down the inhibition effect of weak relationship on innovation performance. The potential absorptive capacity positively moderates the relationship between tacit knowledge sharing and innovation performance, that is, the positive relationship between tacit knowledge sharing and innovation performance will be enhanced when enterprises have higher potential absorptive capacity. The actual absorptive capacity positively moderates the relationship between explicit knowledge sharing and innovation performance, that is, the positive relationship between explicit knowledge sharing and innovation performance will be enhanced when enterprises have higher actual absorptive capacity.

2.2.5 Literature Review of Entrepreneurship Orientation

(1) Entrepreneurship-oriented connotation

In the research of entrepreneurial orientation, many scholars have conducted research on it. Scholars generally believe that entrepreneurial orientation is an important strategic orientation, which is mainly concentrated in its research fields related to enterprise entrepreneurship process, strategic management and decision-making process.

Miller et al., (1983) expanded the object and scope of entrepreneurial research for the first time. They broke through the individual analysis unit of traditional entrepreneurial research, transferred the research object from the individual level to the organizational level, and put forward the concept of corporate entrepreneurship. Although they have not clearly put forward the concept of entrepreneurial orientation, they have defined a conceptual dimension, that is, entrepreneurial orientation is the tendency and attitude of enterprises in strategic choice. Lumpkin et al., (1996) systematically expounded the concept of entrepreneurial orientation. Entrepreneurial orientation includes the types of strategic decisions, decision-making methods, decision-making activities and entrepreneurial process. Entrepreneurial orientation is a mode of strategic orientation, a practice of strategic decision-making to identify and implement entrepreneurial behavior, and its focus is why entrepreneurial activities occur. Li et al. (2010) believe that entrepreneurial orientation can promote enterprises to actively find new business opportunities, develop new products or services, quickly occupy the market, and obtain the leading position in the industry. Su et al., (2010) pointed out that entrepreneurial orientation embodies a kind of enterprise spirit in the process of operation and decision-making. From the above research, it can be seen that entrepreneurial orientation focuses on decision-making styles and business practices in the entrepreneurial process, as well as new technology research and development, new product development, and risk preference choices. Entrepreneurship orientation is related to the actual operation of the enterprise. It emphasizes how to do it, that is, how to enter this field, engage in this business, and choose this industry and market. It is a kind of process concern.

(2) Current status of entrepreneurship-oriented research

In the early stage of entrepreneurial orientation theory, scholars in the field of enterprise strategic management focused on the impact of entrepreneurial orientation on enterprise performance from the aspects of strategy, knowledge and environment. Covin et al.,

(1991) believed that entrepreneurial activities are not only the driving force of economic growth and social development, but also an important feature of high-performance enterprises. Knight (2000) took multinational enterprises as the research object, and thought that entrepreneurial oriented multinational enterprises can better implement market strategy and improve enterprise performance. Zhang (2010) believes that entrepreneurial orientation can promote enterprises to develop new products or services, dare to take all kinds of risks, so as to improve enterprise performance.

Kohtamaki et al. (2019) based on the data set of 86 companies in the food manufacturing industry, the study found that entrepreneurial-oriented EO has a non-linear relationship with sales growth. The results show that in companies with severe resource idleness, the increase in EO from low to medium levels accelerates sales growth; however, in order to take advantage of the sales growth potential of high EO, high absorptive capacity is also required. The study shows the non-linear impact of EO on sales growth, especially the positive moderating effect of EO from medium to high levels, absorptive capacity and resource idleness. Cai et al. (2015) believed that entrepreneurial orientation has an important impact on the improvement of innovation performance, but the relationship between entrepreneurial orientation and innovation performance may also be affected by the characteristics of the executive team and market dynamics. They used 264 questionnaires collected Multiple linear regression and moderating effect testing methods conduct empirical testing of research hypotheses. The results show that entrepreneurial orientation has a positive effect on innovation performance, and the heterogeneity of TMT helps to strengthen the relationship between entrepreneurial orientation and innovation performance; Regardless of the dynamic environment and low dynamic environment, the moderating effect of TMT's common vision on the relationship between entrepreneurial orientation and innovation performance is not significant, but in the dynamic market environment, it can significantly positively regulate the relationship between entrepreneurial orientation and innovation performance.

Based on entrepreneurial orientation theory and rational behavior theory, Xing et al. (2015) constructed a theoretical model of the relationship between entrepreneurial orientation (EO), innovation intention, incubation environment and innovation performance of incubated enterprises by adopting the theoretical paradigm of "entrepreneurial strategy construction innovation intention innovation behavior". The

results show that the two types of entrepreneurial orientation have a significant positive impact on the innovation performance of incubated enterprises, and the impact of creative EO is greater; Innovation intention plays a complete and partial mediating role between discovery EO and innovation performance, and between creation EO and innovation performance; Incubation environment has a positive moderating effect between the two types of entrepreneurial orientation and innovation performance, as well as between creative EO and innovation intention, but the moderating effect between discovery EO and innovation intention is not significant. Peng et al. (2019) believed that entrepreneurship and innovation are the engines to stimulate enterprise vitality and drive economic growth. This thesis verifies the impact of entrepreneurial orientation on innovation performance under the dynamic regulation of external environment. The study finds that three dimensions of entrepreneurial orientation, namely innovation, risk bearing and initiative, help to improve innovation performance, Environmental dynamism positively moderates the relationship between innovation and innovation performance, while risk-taking and the relationship between initiative and innovation performance are not moderated by external environmental dynamism

Miller (1983) believed that entrepreneurial enterprises are keen on market innovation and willing to take certain risks. They often took the lead in the industry and put forward some forward-looking views, so they have high competitiveness in the market. He described these characteristics of entrepreneurial enterprises as innovation, risk-taking and initiative, that is, entrepreneurial orientation. The innovation of entrepreneurial orientation mainly reflects the tendency of an enterprise to participate in and support new ideas and be willing to put new ideas into practice. Based on the existing technology and ideas, enterprises often produce new products, service combinations and even new technologies, which surpass the current state. This thesis argues that when an enterprise leads the industry in producing new products or providing a new service portfolio and can better meet the market demand, the enterprise's entrepreneurial innovation quality and innovation performance are undoubtedly higher. When other enterprises in the industry begin to imitate the enterprise for production and manufacturing, making the R & D and investment of new products or services mature, the enterprise will increase the investment in R & D in order to improve its competitiveness and stabilize its industry status, and produce products and services that are more innovative and difficult to be imitated by

other enterprises, In this process, with the continuous R & D and innovation of enterprises, the innovation performance of enterprises is also improving. Entrepreneurial risk-taking mainly reflects an enterprise's willingness to take risks for high returns. For example, entrepreneurial enterprises are willing to bear heavy debts in order to seize market opportunities to obtain high returns. This thesis argues that the higher the tolerance of uncertainty, the more eager enterprises will be to seize the opportunity of development to explore new markets and implement new ideas. In addition to daring to explore and pursue new things, they also have the courage to bear the consequences of failure. In this way, the stronger the enterprise's ability to bear risks, and the better it can provide talents and talents for the research and development of new products and new technologies Material and financial support, these factors will undoubtedly promote the improvement of enterprise innovation performance.

Entrepreneurship-oriented proactiveness mainly reflects a company's tendency to take action for future expectations or possible changes, gaining initiative through priority actions, discovering market opportunities as much as possible, actively adapting to the existing environment, or creating something suitable for itself Development environment. Some scholars have supplemented the comparison and believe that the proactiveness of enterprises is not only manifested in the proactiveness of enterprises in pursuing opportunities, but also in the willingness to actively respond to competitors. This thesis believes that when a company has the ability to identify market opportunities first and can quickly put them into action, the company can better grasp the development prospects of the products and services produced in the market, which is conducive to the improvement of corporate innovation performance.

2.2.6 Literature Review of Knowledge Transfer Performance

Knowledge transfer refers to the process of knowledge from the knowledge transfer party to the knowledge receiver, and the knowledge receiver can acquire, accumulate, internalize and apply new knowledge. In a broad sense, it includes the transformation of scientific and technological achievements, covering the application of scientific knowledge and science and technology in various aspects. In a narrow sense, it refers to the transfer of research and development results, including knowledge and technology, from the place of creation to the place of use, through education, training, and cooperation. Various methods such as research and development, consulting services, and public

communication are used to improve the quality, skills and knowledge of employees, improve their work efficiency, increase social productivity, and promote economic development. Knowledge transfer includes not only technology transfer, but also knowledge brought by colleges and universities. For example, students bring new knowledge and skills to enterprises after graduation, scientific researchers release research results, spread new knowledge through forums, and provide consulting services for enterprises, which belong to the scope of knowledge transfer.

Regarding the study of knowledge transfer, scholars in different periods focused on different research. Early scholars mainly focused on the transfer of knowledge between different departments within the organization. Later, the center of research was biased towards knowledge transfer between organizations. Afterwards, scholars paid more attention to individual inspections within organizations, that is, knowledge transfer within teams. Generally speaking, the process of knowledge transfer involves at least three key factors. The subjects involved in the knowledge transfer are the knowledge transferor and the knowledge receiver. The second is the object of the transfer, which is the knowledge to be transferred and received. The third is the way of knowledge transfer, that is, the way and medium of knowledge transfer. Therefore, the research on the influencing factors of knowledge transfer performance can start from several key factors involved in knowledge transfer. Von (1994) pointed out that the characteristics of transferred knowledge is an important factor affecting the performance of knowledge transfer. The type of knowledge has different effects on the performance of knowledge transfer. The higher the tacit and complexity of knowledge is, the more difficult the knowledge transfer is (Simonin, 1999), and the worse the performance of knowledge transfer is. The fuzzier the causal relationship and effect of knowledge, the more difficult it is to transfer knowledge (Szulanski, 1996). Gupta et al. (2000) pointed out that the cognitive ability of both sides of knowledge transfer will affect the performance of knowledge transfer.

Knowledge transfer performance refers to the result of knowledge transfer, which means the degree of knowledge transfer, absorption, integration, innovation, and application. It is a comprehensive indicator that reflects the impact of knowledge transfer on knowledge transferees and knowledge receivers. The effect produced by technological innovation ability, market development ability, product innovation ability, etc. Regarding the measurement of knowledge transfer performance, Jian et al., (2009) measured the

technology transfer performance of enterprises in four dimensions: enterprise cost performance, market performance, technological uniqueness performance and innovation performance. Since knowledge can be divided into explicit knowledge and tacit knowledge, some scholars study the influence mechanism of tacit knowledge transfer performance and explicit knowledge transfer performance.

3 HYPOTHESIS DEVELOPMENT

3.1 Research Hypotheses

3.1.1 Relationship Between External Knowledge and Corporate Performance

Knowledge plays an important role in enterprise performance， which is the most important resource and the basis of enterprise innovation. The Knowledge-Based View holds that the management, maintenance and creation of knowledge will promote the innovation of new products. Enterprise innovation depends on the accumulation and collision of knowledge rather than chance and luck. Knowledge is a key intangible asset for enterprise innovation. According to the Knowledge-Based View, the difference of enterprise performance is brought by the heterogeneous resources owned by the enterprise, the different knowledge base and the different ability of applying knowledge will bring different performance (Bierly & Chakrabarti, 1996). These different knowledge bases and abilities will bring huge obstacles to the imitation of competitors, which helps enterprises gain competitive advantage and have important strategic significance for enterprise innovation (Kogut &Zander, 1992). As a special resource, knowledge is an important element of innovation activities and an important production resource for value creation. But it is far from enough that enterprise only rely on its own internal knowledge rather than actively acquiring external knowledge. The Open Innovation Theory holds that the external knowledge and the internal knowledge are equally important, enterprises need to integrate external knowledge and internal knowledge to adapt to the changing external environment. The valuable knowledge of the enterprise comes not only from the inside of the enterprise, but also from the external main body of the enterprise, such as customers, suppliers, universities, governments and so on. Zack (1999) put forward that knowledge is the most important strategic resource of the enterprise. The acquisition, integration, combination, sharing and application of knowledge is an important ability to establish the sustainable competitive advantage of the enterprise. The knowledge stock determines the innovation ability of the enterprise. Identifying, absorbing and applying external knowledge is very important for the development of the enterprise. Based on the above analysis, the following assumptions are proposed:

H1: external knowledge has a positive impact on corporate performance.

Because this thesis divides external knowledge into knowledge acquisition and knowledge sharing according to the process of knowledge acquisition and divides the enterprise performance of knowledge transferring into growth performance and profitability performance, we further investigated the relationship between them in order to get a deeper understanding for the relationship between external knowledge and enterprise performance.

External knowledge acquisition can enrich the knowledge base of the enterprise and increase the knowledge stock of enterprises. According to the Theory of Technological Change at the corporate level, enterprise creativity is the result of increased knowledge base (Griliches, 1990; Henderson et al., 1996). In other words, Increased knowledge can bring creativity to the enterprise and promote enterprises to engage in innovative activities. For a company with a weak knowledge base, expanding in new areas of innovation will be difficult, A firm's core competencies can easily become core rigidities (Leonard, 1995), which is not conducive to the growth and innovation of enterprises and will bind the enterprise to carry on the business expansion and the strategy extension. However, the increase of knowledge base is derived from the long-term knowledge-enhancing investment and external knowledge acquisition (Cohen et al., 1989; Huber, 1991). External knowledge acquisition is an important part of organizational learning, the sources of external knowledge come from external organizations associated with the company. The process of acquiring knowledge include conscious deliberate learning and unconscious knowledge spillover effects. Mesquita et al (2008) found it can enhance the specialization of the company's resources, create price advantages and accelerate product innovation with breaking the internal boundaries and accessing to complementary resources though cooperation with customers, suppliers and competitors in neighboring regions.

The research of Becker and Dietz shows that cooperation with external subjects can improve the R&D intensity of enterprises. Laursen et al. (2006) have studied the relationship between corporate performance and the breadth and depth of exploration of external knowledge sources. It turns out that the relationship is an inverted U-shaped relationship. When the acquisition of knowledge exceeds a certain value, the excessive knowledge searching will be caused and the innovation performance of enterprises will be reduced. However, this is not common among Chinese companies (Li et al., 2014).

Chinese scholars Chen and Yang (2014) made a research review on the relationship between external knowledge and innovation performance. Through a systematic review of previous studies, they found the existing research exploring the channels of enterprises obtaining external knowledge sources and the influence of different cooperation methods on performance. Enterprises increase the based knowledge with acquiring knowledge from outside can help enterprises to achieve innovation and promote the growth of enterprises. Meanwhile, as an enterprise resource, knowledge can form the core competitiveness of the enterprise. It can make companies stand out and make more profits. To sum up, we can make the following assumptions:

H1a: knowledge acquisition has a positive impact on enterprise growth performance.

H1b: knowledge acquisition has a positive impact on corporate profitability performance.

After acquiring the knowledge from the outside, it is necessary to internalize the external knowledge into the enterprise's own knowledge and apply it to the enterprise in order to perform its function. Knowledge sharing can internalize external knowledge well and test the transfer effect of enterprise knowledge. Knowledge sharing refers to the process of exchanging knowledge and creating new knowledge between individuals. The owners of knowledge transfer knowledge and "externalize" knowledge that they internalize. The recipients of knowledge recognize knowledge by listening, reading, imitating and trying, which is actually another internalizing behavior in fact, forming a continuous process of knowledge transfer. That is, enterprises acquire knowledge from the outside, then combine with their own knowledge and internalize knowledge into their own knowledge, and then apply it through knowledge sharing. Finally, the knowledge is externalized again, which form a circulatory system. Knowledge sharing is the mutual transformation of explicit and tacit knowledge within a team. Through the continuous cycle of socialization, externalization, combination, internalization process (SECI), individual knowledge is constantly reorganized and integrated into team knowledge, and on this basis, new knowledge is created to promote the spiral rise of team knowledge. Knowledge sharing is the core of knowledge management, and a large number of researches have shown that the knowledge management is implemented in order to improve the innovation performance of enterprises, so knowledge sharing will have a certain impact on enterprise performance. If the enterprise shares knowledge for a long time, it will form an organizational culture that cultivate the culture and atmosphere of knowledge sharing and

promote the members of the organization to share their own practical experience and other knowledge spontaneously (Ge, 2015). In this way, knowledge sharing among internal members can transform internal knowledge into external knowledge, increase the knowledge stock of overall enterprises, and then improve the performance of enterprises. On the one hand, enterprises actively share knowledge will attract partners to take the same approach, which will bring a win-win result, to be specific, both sides of knowledge sharing will gain double knowledge and may even bring greater breakthroughs in their own knowledge integration. It will improve the innovation of enterprises and make enterprises have great potential, that is, knowledge sharing can promote the growth performance of enterprises. On the other hand, knowledge sharing can help customers learn more about their products information and gain customers' trust. Sharing knowledge within the enterprise encourage each team to provide its own knowledge storage, which can improve work efficiency and reduce enterprise costs. To sum up, the following assumptions are put forward:

H1c: knowledge sharing has a positive impact on growth performance of enterprise.

H1d: knowledge sharing has a positive impact on profitability performance of enterprise.

3.1.2 Relationship between External Knowledge and Collaborative Innovation

Collaborative innovation refers to the continuous innovation of an enterprise by sharing knowledge, ideas, technology (Ketchen et al, 2007), which is based on knowledge appreciation. Chen and Yang (2012) thought the government, enterprises and universities achieve technological innovation by carrying out the innovation combination form of long-span integration, in order to realize value increment and value creation. Xie, Fang (2015) concluded that the collaborative innovation system is a complex and nonlinear open system by studying the literature on collaborative innovation. They found the collaborative innovation system need to bring together technology, information, knowledge across borders so as to achieve the expansion of synergy through the synergy of cross-border elements. Collaborative innovation can be divided into exploratory collaborative innovation and exploitative collaborative innovation, Exploratory collaborative innovation refers to the process by which companies acquire new knowledge though various ways such as exploration, creation and experiment, and then develop new products and services (Tiwana, 2010). In order to meet the needs of customers, enterprises can take exploitative collaborative innovation activities, that is to

say, the enterprises can expand and perfect the current industrial line and improve the functions of products through refining and popularizing their existing knowledge reserves and technical capabilities (March,1991). We can see the knowledge is the foundation of exploitative innovation and the premise of exploratory innovation from the above description of exploratory innovation and exploitative innovation. The following assumption are made:

H2: External knowledge has a significant impact on collaborative innovation.

External knowledge acquisition refers to the process of obtaining and using knowledge from external knowledge sources (Holsapple et al，2001). Knowledge is the source of innovation activities. Many knowledge resources needed for collaborative innovation can only be obtained from the outside of the enterprise, especially for Chinese enterprises, the scarce resources accumulated by themselves are so less that it is necessary to obtain the key knowledge from the outside. Enterprises and potential external knowledge sources, including customers, suppliers, competitors, collaborators, can form a cooperative relationship network, the University Science Park is such a network. In this network system, the innovation activities of enterprises are closely related to the behavior of enterprises to acquire knowledge. Through the acquisition of external knowledge, enterprises can acquire a lot of knowledge and promote the emergence of new ideas. Some studies have shown that enterprises can improve the probability of exploratory collaborative innovation by combining the external knowledge with the exploitative collaborative innovation. At the same time, through exploratory collaborative innovation, enterprises can acquire a lot of new knowledge. The purchase and merger and acquisition of technology is a way for enterprises to acquire external knowledge. Technology purchase can help enterprises acquire more mature technology. The purchase of key technologies can realize the exploitative collaborative innovation of enterprises in the early stage of technology development (Chen, 2003). The knowledge obtained from colleges and universities and scientific research personnel can increase the scientific knowledge reserve of enterprises, and the industry knowledge obtained from competitors and collaborators is another source for enterprises to acquire knowledge. By obtaining scientific knowledge and industry knowledge, new knowledge within the enterprise is increased, so that enterprises can make better innovation according to the external environment. At the same time, external knowledge acquisition is helpful to overcome

organizational inertia, and the diversity of external knowledge sources enables enterprises to contact different ways of thinking, which can promote enterprises to question existing cognitive structures, improve old ideas and upgrade enterprise organizational structure and realize exploratory collaborative innovation effectively. Wu Nan et al (2015) divided the acquisition of external knowledge into alliance knowledge acquisition and market knowledge acquisition. The results show that alliance knowledge acquisition plays a greater role in ambidextrous innovation than market knowledge acquisition. External knowledge acquisition has a significant impact on enterprise ambidextrous innovation. Based on the above analysis, make assumptions:

H2a: knowledge acquisition has a significant positive impact on exploratory collaborative innovation.

H2b: knowledge acquisition has a significant positive impact on exploitative collaborative innovation.

Enterprises need a lot of knowledge base to carry out collaborative innovation. Through knowledge sharing, individual and scattered knowledge can flow within the enterprise. Then it can be integrated effectively to form the collective knowledge of the enterprise and expand the knowledge base needed by enterprises to carry out collaborative innovation (Grant et al,1996). Knowledge sharing can promote both exploratory collaborative innovation and exploitative collaborative innovation. Sharing knowledge with external organizations is a form of applying their own knowledge for enterprises. Through sharing, enterprises will be more familiar with their own knowledge and skills. Through the exchange and interaction of various departments, employees can exchange knowledge and learn the knowledge and skills of other employees to improve their knowledge stock. After knowledge sharing, employees can deepen their understanding of the existing knowledge and then improve their own work. For enterprises, knowledge sharing has the same role, it can increase the knowledge base, improves their own work and promote the exploitative collaborative innovation of enterprises. At the same time, enterprises can reorganize and create new knowledge and serve exploratory collaborative innovation through knowledge sharing and integrating decentralized knowledge in different fields. Knowledge sharing provides the conditions for the combination of enterprise knowledge, which is conductive to produce new knowledge and new ideas and provides the foundation for the improvement of ability of exploration collaboration

innovation. Zhao et al., (2014) studied the relationship between external knowledge acquisition, internal knowledge sharing and mutation innovation, and took the exploration-application ambidextrous innovation strategy as the regulating variable and concluded that the exploratory innovation strategy played a positive role in regulating the internal knowledge sharing and mutation innovation. Zhou et al., (2014) studied the relationship between organizational ambidexterity and performance from the perspective of organizational learning and obtained a positive correlation between organizational learning and organizational ambidexterity. Organizational learning refers to the process by which individuals form cognition and memory to develop and share knowledge. Based on the above analysis, make assumptions:

H2c: knowledge sharing has a significant positive impact on exploratory collaborative innovation.

H2d: knowledge sharing has a significant positive impact on exploitative collaborative innovation.

3.1.3 Relationship Between Collaborative Innovation and Enterprise Performance

Many scholars have shown that there is a significant positive effect between collaborative innovation and corporate performance. With the deepening of research on collaborative innovation in academic circles, the role of collaborative innovation level on enterprise performance has been paid more and more attention. Cowan et al., (2004) discussed the level of collaborative innovation in the metropolitan area. The results showed that when the innovation elements in the region reach a unified and coordinated state, it will play a significant role in promoting the innovation performance of the metropolitan area. Through studying the cooperation between innovation subjects in the region, Welsh et al., (2008) found that industry-university-research collaborative innovation can promote the conversion rate of scientific and technological achievements in colleges and research institutions and improve the production capacity of enterprises, which help enterprises obtain objective economic and social benefits and promote economic development. Deng (2016) studied the collaborative innovation among enterprises, universities, scientific research institutions and government, and applied the regression analysis to analysis the innovation performance using the collaborative innovation indicators. The results confirmed the positive effect of regional collaborative innovation level on innovation performance.

Exploratory collaborative innovation emphasizes that enterprises explore new customers and new market needs and acquire new knowledge, technology and skills. By introducing new knowledge, enterprises can acquire unique core resources, so as to facilitate the special design of products, obtain innovative products, and then improve the competitiveness of enterprises and the performance of organizations (Javier, 2014). Specifically, exploratory collaborative innovation can create new markets, so that enterprises have greater market share that can bring returns to enterprises in the long run. The exploratory collaborative can excavate new technology and product, open new market and promote the innovation process of enterprises. In addition, exploratory collaborative innovation can help enterprises accumulate new knowledge, develop new products, meet the new needs of customers, obtain first-mover advantages, surpass competitors and improve their competitive advantages. The exploitative collaborative innovation emphasizes that improving the original ability and mining the potential value of products by the use of existing knowledge, which is helpful for enterprises to meet the needs of existing customers and realize the efficiency and incremental innovation of product development (Liu et al., 2018). The exploitative collaborative innovation can help enterprises obtain short-term benefits and improve the profitability performance of enterprises through improving the existing products by digging into the customer's demand and using more high-quality products and services to surpass the competitors. At the same time, more attention should be paid to maintaining the balance between exploration and exploitation. Exploration activities are conducive to achieving long-term goals and improving the organization's adaptation to major changes in the environment. But if we only focus on exploration and ignore the exploitative innovation of the organization, the profitability performance of organization will be effect and the enterprise will not survive due to it may not get the corresponding return on investment and fall into financial difficulties. The exploitative collaborative innovation, which can provide resources and knowledge for the organization, is related to the short-term goal of the organization, that is, it is closely related to the profitability of the enterprise. However, if we only focus on the exploitative innovation, the enterprises will have difficulties in achieving long-term survival and the growth performance of enterprise will be low due to it may not be able to adapt to changes in the environment. In summary, the following assumptions are made:

H3: collaborative innovation has a significant positive effect on enterprise performance.

H3a: exploratory collaborative innovation has a significant positive effect on the growth performance

H3b: exploratory collaborative innovation has a significant positive impact on the profitability performance

H3c: exploitative collaborative innovation has a significant positive impact on growth performance

H3d: exploitative collaborative innovation has a significant positive impact on the profitability performance

3.1.4 Mediating Effect of Collaborative Innovation

Some scholars believe that external knowledge can effectively improve the performance of knowledge transfer in enterprises, at the same time, some scholars propose that the effect of external knowledge on performance is not obvious in some cases. This may because the external knowledge and the performance of knowledge transfer are not always a direct relationship, the effect sometimes is achieved through some mediating variables. The collaborative innovation may provide an indirect transmission path in the process of external knowledge affecting enterprise performance of knowledge transfer. The stronger the knowledge acquisition ability, the higher the knowledge stock of the enterprise. If enterprise has more knowledge, it will promote the activities of collaborative innovation within the enterprise. Through the collaborative innovation, the corporate performance will increase. Similarly, the higher the level of knowledge sharing, the stronger the ability of exploratory collaborative innovation and exploitative collaborative innovation. The exploratory collaborative innovation through the exploration of new knowledge, the exploitative collaborative innovation through the excavate deeply of existing knowledge, and applying the sharing knowledge, which can improve the corporate performance. Based on the above description, the hypothesis is put forward:

H4: the collaborative innovation plays a mediating role between external knowledge and knowledge transfer performance.

H4a: the exploratory collaborative innovation plays a mediating role between external knowledge and enterprise performance.

H4a1: the exploratory collaborative innovation plays a mediating role in knowledge acquisition and enterprise growth.

H4a2：the exploratory collaborative innovation plays a mediating role in knowledge acquisition and enterprise profitability.

H4a3：the exploratory collaborative innovation plays a mediating role in knowledge sharing and enterprise growth.

H4a4：the exploratory collaborative innovation plays a mediating role in knowledge sharing and enterprise profitability.

H4b：the exploitative collaborative innovation plays a mediating role between external knowledge and enterprise performance.

H4b1：the exploitative collaborative innovation plays a mediating role in knowledge acquisition and enterprise growth.

H4b2：the exploitative collaborative innovation plays a mediating role in knowledge acquisition and enterprise profitability.

H4b3：the exploitative collaborative innovation plays a mediating role in knowledge sharing and enterprise growth.

H4b4：the exploitative collaborative innovation plays a mediating role in external knowledge and enterprise profitability.

3.1.5 Moderating Role of Absorptive Capacity

Cohen et al., (1989) are the first person to propose the concept of absorptive capacity, they believe that absorptive capacity refers to "the ability of an enterprise to identify, absorb and use information in its external environment for business activities". The absorptive capacity can affect the business outcome of the enterprise like products, services, or patents. At the same time, it will affect the knowledge outcome of the enterprise. For example, the general knowledge, scientific knowledge, technical knowledge and organizational knowledge are likely to be affected. Many scholars have come to the conclusion that, the absorptive capacity can promote the performance of the enterprise. The enterprises with higher absorptive capacity can improve their performance by improving the utilization of knowledge; on the contrary, if the absorptive capacity of enterprise is poor, the use of knowledge will be very inefficient, so the impact that knowledge on innovation performance is little. Zahra et al., (2002) divided the absorptive capacity into two dimensions: potential absorptive capacity and real absorptive capacity. The potential absorptive capacity refers to the ability to acquire and digest external

knowledge from external information. Zhao et al., (2014) pointed out that the stronger the potential absorptive capacity is, the more valuable explicit and invisible knowledge can be obtained from external complex and changeable environments, which provide more knowledge resources for innovative activities. The stronger the digestion ability of enterprises to external knowledge is, that is, the stronger the potential absorptive ability, the more innovative thinking can be produced, and then provide knowledge guarantee for innovative activities.

Realistic absorptive capacity refers to the ability to integrate existing knowledge with new knowledge and apply it to innovative activities. The stronger the realistic absorptive ability is, the better it can help enterprises to improve performance through simplifying complex knowledge, concretizing abstract knowledge and internalizing external knowledge, technology and other resources into their own resources. The efficient use of knowledge is an important link to achieve knowledge appreciation, but also is the purpose of enterprises to absorb external knowledge. Escribano et al., (2009) also proved that the knowledge absorptive ability of enterprises with higher income from external environment is very high. In addition, Dong et al., (2018) took the listed companies in growth enterprise market from 2010 to 2013 as the research object, proved that the absorptive ability positively regulates the impact of technological mergers and acquisitions on innovation performance, that is, the stronger the absorptive ability is, the stronger the innovation dynamic ability of the company after the technology merger and acquisition is. Although enterprises can promote knowledge exchange and obtain more resources such as invisible knowledge and information through the establishment of stable social relations, limited by the inherent resources of enterprises, they cannot directly use the acquired resources for innovation activities. It is necessary to study the relationship between external knowledge, collaborative innovation and knowledge transfer performance, and match the absorptive ability of the enterprise itself in order to improve the performance level of the enterprise better. Based on the above analysis, this thesis holds that absorptive capacity (acquisition, digestion, transformation, application) will have an impact on the relationship between external knowledge and collaborative innovation. Based on the above explanations, the following assumptions are made:

H5： absorptive capacity plays a moderating role between external knowledge and collaborative innovation.

H5a: acquisition ability plays a moderating effect between external knowledge and collaborative innovation.

H5b: assimilate plays a moderating effect between external knowledge and collaborative innovation.

H5c: transformation ability plays a moderating effect between external knowledge and collaborative innovation.

H5d: application ability plays a moderating effect between external knowledge and collaborative innovation.

3.1.6 Moderating Role of Entrepreneurial Orientation

The entrepreneurship orientation is defined as the strategic tendency of enterprises in the face of competition, which interferes with the influence of collaborative innovation on enterprise performance（Bai et al., 2015). Entrepreneurial orientation indicates the degree of a firm's appetite for risk, which including innovativeness, risk-taking, and proactivity. Innovativeness indicates a firm's propensity to engage in and support new ideas and to be willing to bring innovative ideas to life; risk-taking indicates a firm's propensity to take risks for high rewards; and proactivity reflects a firm's propensity to act on possible future changes. Drawing on the dynamic capability perspective, EO refers to a firm’s ability to pursue innovation, proact and take risk. it is not only applicable to start-ups, but also involves decisions related to ‘entrepreneurial orientation’ when expanding into new markets and developing new businesses. In a fierce competitive market, customers may face lots of different choices to meet their needs and desires, under this circumstance, companies tend to become more sensitive and responsive to changing customer needs. In this way, innovative products and services are launched in order to open up the market. Whether it is the needs expressed by customers or the potential needs not perceived by customers, enterprises will research, investigate and respond to the needs and preferences of customers as much as possible (Chen et al., 2015). Therefore, the cooperative innovation activities of enterprises will be promoted. As entrepreneurship grows, companies need to open up markets for innovative products. It is inevitable to emphasize the strategy of collaborative innovation. When the entrepreneurial orientation is higher, the more enterprises attach importance to collaborative innovation. The enterprises will take some measures such as actively looking for customers' potential needs, increasing

additional value-added services and improving existing products, in order to preempt competitors to meet customer needs and expectations and maintain the loyal customers. Similarly, in an entrepreneurial context, companies will also make gradual improvements to existing customer needs. Although the speed and manner of improvement are relatively mild, also can gradually improve the performance of enterprises.

The higher the entrepreneurial orientation is, when facing strong external competitors, enterprises will be willing to take the initiative to invest more resources to identify the potential needs of customers for the sustainable operation of enterprises. It is necessary to develop and market new products and services faster than competitors. So as to attract the attention of customers among multiple competitors, the specifications, efficiency and quality of the products must be more stable and competitive than competitors, and the service conditions are more favorable than competitors, so that customers are satisfied, assured and fully accepted without considering other competitors, thereby increasing sales performance and market share (Chen et al., 2013). Similarly, Although the action of exploitative collaborative innovation only responds to the needs of customers and develops products, in the eyes of customers, such an enterprise strategy can also consolidate and provide customers with continuously improved products. Although its advantages are not obvious, in the cost control at the financial level can be minimized and the overall financial performance is good. Based on the above explanations, the following assumptions are made:

H6: entrepreneurship orientation plays a moderating effect between collaborative innovation and corporate performance.

H6a: innovation plays a moderating effect between collaborative innovation and corporate performance.

H6b: risk-taking plays a moderating effect between collaborative innovation and corporate performance.

H6c: proactiveness plays a moderating effect between collaborative innovation and corporate performance.

3.1.7 Assumption Summary

In this thesis, six main assumptions are made. H1 hypothesizes that external knowledge significantly and positively affects firm performance, and the four sub-hypotheses H1a-H1b relate to the specific relationship between external knowledge and firm performance;

H2 hypothesizes that external knowledge significantly and positively affects collaborative innovation, and the four sub-hypotheses H2a-H2b relate to the specific relationship between external knowledge and collaborative innovation; H3 hypothesizes that collaborative innovation significantly and positively affects firm performance, and the four sub-hypotheses H3a-H3b relate to the specific relationship between collaborative innovation and firm performance; H4 hypothesizes that collaborative innovation plays a mediating role between external knowledge and firm performance, and H4a and H4b are about exploring the mediating role of exploratory collaborative innovation and exploitative collaborative innovation respectively; H5 hypothesizes that absorptive capacity plays a moderating role between external knowledge and collaborative innovation, and H6 hypothesizes that entrepreneurial orientation plays a moderating role between co-innovation and firm performance. The assumptions are summarized in Table 3-1.

Table 3-1 the summary of assumptions

Research subjects	Specific content
H1	External knowledge has a positive impact on corporate performance
H1a	Knowledge acquisition has a positive effect on growth performance
H1b	Knowledge acquisition has a positive effect on enterprise profitability performance
H1c	Knowledge sharing has a positive effect on growth performance
H1d	Knowledge sharing has a positive effect on enterprise profitability performance
H2	External knowledge has a significant positive impact on collaborative innovation
H2a	Knowledge acquisition has a significant positive effect on exploratory collaborative innovation
H2b	Knowledge acquisition has a significant positive effect on exploitative collaborative innovation
H2c	Knowledge sharing has a significant positive effect on exploratory collaborative innovation
H2d	Knowledge sharing has a significant positive effect on exploitative collaborative innovation

H3	Collaborative innovation has a significant positive impact on corporate performance
H3a	Exploratory collaborative innovation has a significant positive effect on growth performance
H3b	Exploratory collaborative innovation has a significant positive effect on the profitability of enterprises
H3c	Exploitative collaborative innovation has a significant positive impact on growth performance
H3d	Exploitative collaborative innovation has a significant positive impact on the profitability of enterprises
H4	Collaborative innovation plays a mediating role between external knowledge and knowledge transfer performance.
H4a	Exploratory collaborative innovation plays a mediating role between external knowledge and enterprise performance
H4a1	Exploratory Collaborative Innovation plays a mediating role in knowledge acquisition and enterprise growth
H4a2	Exploratory collaborative innovation plays a mediating role in knowledge acquisition and enterprise profitability
H4a3	Exploratory Collaborative Innovation plays a mediating role in knowledge sharing and enterprise growth
H4a4	Exploratory collaborative innovation plays a mediating role in knowledge sharing and enterprise profitability
H4b	Exploitative collaborative innovation plays a mediating role between external knowledge and enterprise performance
H4b1	Exploitative collaborative innovation plays a mediating role in knowledge acquisition and enterprise growth
H4b2	Exploitative collaborative innovation plays a mediating role in knowledge acquisition and enterprise profitability
H4b3	Exploitative collaborative innovation plays a mediating role in knowledge sharing and enterprise growth
H4b4	Exploitative collaborative innovation plays a mediating role in knowledge sharing and enterprise profitability
H5	Absorption plays a moderating role between external knowledge and collaborative innovation

H5a	Acquisition ability plays a moderating role between external knowledge and collaborative innovation
H5b	Assimilate ability plays a moderating role between external knowledge and collaborative innovation
H5c	Transformation ability plays a moderating role between external knowledge and collaborative innovation
H5d	Application ability plays a moderating role between external knowledge and collaborative innovation
H6	Entrepreneurship orientation plays a moderating role between collaborative innovation and corporate performance
H6a	Innovation plays a moderating role between collaborative innovation and corporate performance
H6b	Risk-taking plays a moderating role between collaborative innovation and corporate performance
H6c	proactiveness plays a moderating role between collaborative innovation and corporate performance

3.2 Conceptual Model

Based on the theory of knowledge base and synergy theory, focusing on the research topic, this thesis constructs the conceptual model diagram as shown in figure 3-1, which reflects the basic structural relationship among the five variables of external knowledge, collaborative innovation, enterprise performance, absorptive capacity and entrepreneurial orientation. The independent variable is external knowledge, from two dimensions of knowledge acquisition and knowledge sharing; the mediating variable is collaborative innovation, from two dimensions of exploratory collaborative innovation and exploitative collaborative innovation; the dependent variable is enterprise performance of knowledge transfer. There are two moderating variables including absorptive capacity and entrepreneurial orientation, which are introduced to investigate their moderating effect in the path of external knowledge transfer.

We can see the following points from the diagram, firstly, the verification of the influence relationship between external knowledge and enterprise performance constitutes hypothesis H1; secondly, the verification of the influence relationship between external knowledge and collaborative innovation constitutes hypothesis H2; thirdly, the

verification of the influence relationship between collaborative innovation and enterprise performance constitutes hypothesis H3; Fourthly, H4 is proposed to verify that collaborative innovation mediates the relationship between external knowledge and enterprise performance; Fifthly, absorptive capacity constitutes hypothesis H5 for regulating the relationship between external knowledge and collaborative innovation; Sixth, entrepreneurial orientation constitutes hypothetical H6 for regulating the relationship between collaborative innovation and corporate performance.

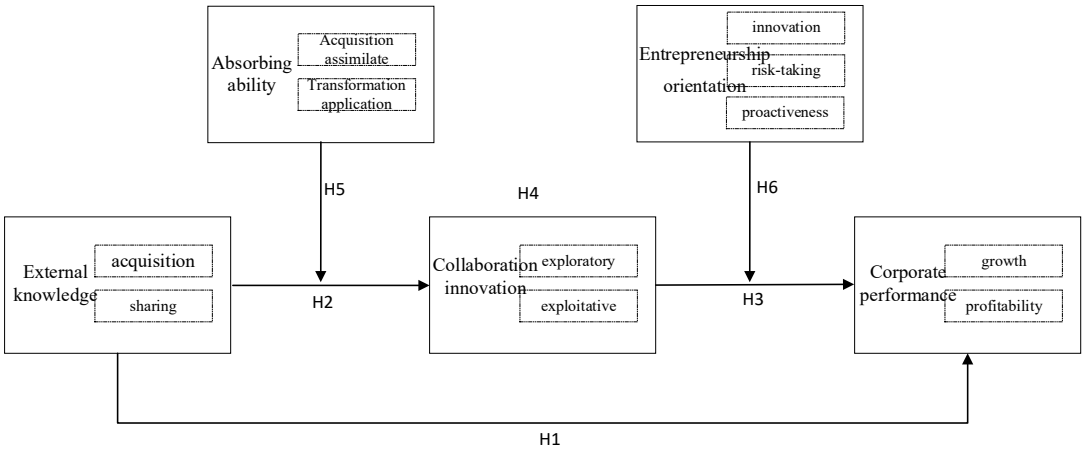

Figure 3-1 The concept model of impact mechanism of knowledge transfer performance

4 RESEARCH DESIGN AND METHODOLOGY

This chapter describes the methodology used to empirically examine the theoretical model established through the literature review. A cross-sectional survey design was used for collecting data from firms in the University Science and Technology Park. To analyze the collected data and test the research hypotheses, several methods were employed. In the following section, I discuss the data collection procedure, variables' measurements and control variables used in this study.

4.1 Questionnaire design

The design of the questionnaire is an important work in the initial stage of the study. Whether the design of the questionnaire is reasonable or not is the key to determine the reliability and credibility of the data. Rong (2005) proposed that the following principles should be followed in designing the questionnaire. First of all, the research content of the questionnaire should be consistent with the variable connotation and the theoretical framework. Secondly, the questions involved in the questionnaire should be easily answered, the description of the questions should be clear and easy to understand, and the questions should not involve personal privacy and corporate secrets; In addition, it is necessary to conduct predictive prior-test of formal investigations.

Based on the above design principles, the process of designing questionnaire is as follows. Drawing on the literature review, we developed a draft of questionnaire. Second, the pre-test (pilot study) was conducted to identify ambiguous questions and improve the adequacy of research instruments. Third, I used back-translation to ensure conceptual equivalence and compatibility of Chinese survey to the English original one. Fourth, questionnaire was revised based on the feedback and the result of pre-test study.

The questionnaire consists of six parts. The first part included items measuring construct of performance; the second part had items used to measure external knowledge sharing and acquisition; the third part had items of innovation; the fourth part included items for absorptive capacity measures; items in fifth part were related to entrepreneurial orientation; and the last part included items related to firm characteristics.

Following Brislin's (1970) recommendation, the questionnaire translated and back translated. In particular, the original English questionnaire was translated to Mandarin by the person who did not know about the objective of the study. Then, the translated

questionnaire was back-translated to English by another bilingual translator who did not have access to the original survey questionnaire.

4.2 Pretests of Small Sample

In order to ensure the reliability and validity of the formal questionnaire, we carried out a pre-test before issuing the formal questionnaire and carried out a preliminary test on the reliability and validity of the scale. According to the results of reliability and validity analysis, the initial questionnaire items were appropriately deleted and modified to form the final questionnaire. The small sample survey started on October 15, 2020. The employees of the university science and technology park were selected for pre-testing. A total of 70 questionnaires were distributed, remaining 63 after deletion of invalid questionnaires, such as too many information vacancies and obviously not serious answers. The recovery efficiency is 90%.

4.2.1 Descriptive Analysis

(1) Basic information of enterprises

As can be seen from Table 4-1, more than half of the enterprises have been established for more than 10 years. Among the surveyed companies, most companies with a scale of less than 50 employees, which accounted for 44.44%. From the point of view of the proportion of employees with undergraduate degree or above, there are 31 whose employees with undergraduate degree or above accounting for more than 5%. From the perspective of industry, the manufacturing industry is on the high side, accounting for 61.9%. The product market of most enterprises is in the province. According to the frequency of interaction with colleges and universities in informal activities, nearly 70% of enterprises have less interact with colleges and universities, which may be a reason for the low performance of enterprises.

Table 4-1 the basic information of enterprises

	Basic information	frequency	percentage
The age of enterprises	5 years or less	22	34.92%
	5-10 years	8	12.70%
	more than 10 years	33	52.38%
Enterprise scale (2019)	Under 50	28	44.44%
	50-100 persons	11	17.46%
	More than 100	24	38.10%
	less than 5%	31	49.21%
	5% to less than 10%	16	25.40%

Percentage of undergraduate and above	25% or more	16	25.40%
industry	IT	3	4.8%
	mechatronics	1	1.6%
	Telecommunication	1	1.6%
	Biomedicine	4	6.3%
	manufacturing industry	39	61.9%
	chemical industry	4	6.3%
	Others	11	17.5%
Major produce markets（Last 3 years）	Local / regional within your province	30	47.6%
	National (other regions of [your country])	25	39.7%
	All other countries	8	12.7%
Frequency of interaction with universities in informal activities	no relationship	21	33.3%
	very infrequently, once a year or less	24	38.1%
	once every 6 months or less	8	12.7%
	being every 2 months	9	14.3%
	being every being every two weeks	1	1.6%

(2) Basic personal information

The basic personal situation of the respondents is shown in Table 4-2. We can see that the respondents over 40 years of age account for 61.9%. Generally speaking, this part of the group has been working in the company for a long time and has more experience. Generally, they are middle and high-level management personnel of the company and have a better understanding of the company. From the perspective of gender, there are more women among the respondents. In terms of academic qualifications, 38.1% of the respondents have a bachelor' degree or above. The middle level and above managers accounted for 73% of the surveyed positions. On the whole, the respondents have a high degree of understanding of the company and are a more suitable research object, which can ensure the reliability and representativeness of the survey data.

Table 4-2 the basic information of respondents

	Basic information	Frequency	percentage
age	20-29 years	5	7.90%
	30-39 years	19	30.2%
	40-49 years	36	57.1%
	50-60 years	2	3.2%
	60 plus years	1	1.6%
gender	Male	23	36.5%
	Female	40	63.5%

Level of Education	High school	7	11.1%
	Diploma	32	50.8%
	Undergraduate technical degree	7	11.1%
	Undergraduate non-technical degree	10	15.9%
	Postgraduate technical degree	2	3.2%
	Postgraduate non-technical degree	5	7.9%
position	CEO	1	1.6%
	Founder	5	7.9%
	Senior manager/director	8	12.7%
	Middle manager	31	49.2%
	foreperson/Supervisor	1	1.6%
	worker/employee	17	27%

4.2.2 Reliability Analysis

The purpose of reliability analysis of small sample data is to streamline the questionnaire, adjusting and modifying some inappropriate items to improve the reliability of the whole questionnaire. Some questions have very little contribution to the scale, and even reduce the reliability of the entire scale. For these questionnaire items, it is necessary to delete to improve the reliability of the measurement variables. The process of deleting the item is the process of purifying the item. At present, the more mature purification method is to use the Corrected-item Total Correlation (CITC), which usually use 0.3 as the purification standard, removing those questionnaire items that the value is less than 0.3 and will increase the Cronbach's a coefficient after deletion. Here, Cronbach's a coefficient was used to test the reliability of the questionnaire. Different scholars have different views on the standard of questionnaire coefficient, but most scholars believe that 0.7 is the minimum acceptance value of reliability. Therefore, we take 0.7 as the criterion of reliability test.

(1) Reliability analysis of external knowledge

By using CITC method and Cronbach’s a coefficient, the scale of knowledge acquisition was purified. The specific results are shown in Table 4-3. It can be seen that the CITC value of all items is greater than 0.3 and the Cronbach's a coefficient is 0.983, which shows the measurement scale of knowledge acquisition has good reliability.

Table 4-3 the CITC and Cronbach's a coefficient of knowledge acquisition

	Scale average after removal of items	Scale variance after deletion	CITC	Cronbach coefficient after item deletion	Cronbach's a coefficient （N=22）
CFIntn1	83.524	1163.157	0.845	0.982	0.983
CFIntn2	83.143	1158.931	0.83	0.982	
CFIntn3	83.238	1168.7	0.777	0.982	
CFIntn4	83.603	1166.792	0.789	0.982	
CFIntn5	82.714	1166.562	0.781	0.982	
CFExtn1	83.206	1147.941	0.898	0.982	
CFExtn2	83.286	1149.369	0.929	0.981	
CFExtn3	83.381	1155.272	0.852	0.982	
CFExtn4	83.349	1147.005	0.906	0.982	
CFExtn5	83.095	1153.507	0.861	0.982	
CFExtn6	83.603	1155.211	0.86	0.982	
CFExtn7	83.587	1156.02	0.834	0.982	
CFExtn8	82.778	1161.724	0.775	0.982	
CFExtn9	83.286	1146.433	0.888	0.982	
CFExtn10	83.413	1149.827	0.912	0.982	
CFExtn11	82.587	1166.375	0.74	0.983	
CFAcad1	83.667	1154.194	0.867	0.982	
CFAcad2	83.159	1154.749	0.85	0.982	
CFAcad3	83.222	1154.079	0.851	0.982	
CFAcad4	83.286	1152.982	0.848	0.982	
CFAcad5	83.333	1154.903	0.84	0.982	
CFAcad6	83.206	1156.295	0.801	0.982	

Using the same method to measure the variable of knowledge sharing, the results are shown in Table 4-4. It can be seen that the CITC values of all items are greater than 0.3, and the Cronbach's α coefficient is 0.983, which is greater than 0.7, indicating that the reliability of the measurement scale for knowledge sharing is good.

Table 4-4 the CITC and Cronbach's a coefficient of knowledge sharing

	Scale average after removal of items	Scale variance after deletion	CITC	Cronbach coefficient after item deletion	Cronbach's a coefficient （N=9）
KS1	49.000	132.548	0.881	0.983	0.983
KS2	48.980	131.209	0.913	0.981	
KS3	49.050	131.530	0.910	0.982	
KS4	48.950	129.594	0.943	0.980	
KS	48.830	131.082	0.938	0.980	
KS6	48.870	132.209	0.933	0.981	
KS7	48.830	130.308	0.956	0.980	
KS8	48.730	132.394	0.945	0.980	
KS9	48.760	132.281	0.884	0.983	

(2) Reliability analysis of collaborative innovation

By using CITC method and Cronbach's α coefficient, the scale of collaborative innovation was purified. The specific results are shown in Table 4-5. It can be seen that the CITC value of all items is greater than 0.3, the Cronbach's α coefficient is 0.962, which is greater than 0.7, and the measurement scale of collaborative innovation has good reliability.

Table 4-5 the CITC and Cronbach's a coefficient of collaborative innovation

	Scale average after removal of items	Scale variance after deletion	CITC	Cronbach coefficient after item deletion	Cronbach's a coefficient （N=14）
Expr1	82.19	216.253	0.732	0.96	0.962
Expr2	82.302	213.666	0.732	0.96	
Expr3	82.397	210.598	0.781	0.959	
Expr4	82.286	215.369	0.781	0.959	
Expr5	82.206	211.747	0.85	0.958	
Expr6	82.27	215.813	0.687	0.961	
Expr7	82.127	215.467	0.793	0.959	
Expo1	82.222	211.337	0.822	0.958	
Expo2	82.333	209	0.864	0.957	
Expo3	82.27	211.942	0.817	0.958	
Expo4	82.032	214.16	0.804	0.959	
Expo5	82.27	210.974	0.852	0.957	
Expo6	82.206	212.779	0.797	0.959	
Expo7	82.317	212.22	0.709	0.961	

(3) Reliability analysis of corporate performance

The method of CITC and the Cronbach coefficient are used to purify the scale of corporate performance. The specific results are shown in Table 4-6. It can be seen that the CITC values of all items are greater than 0.3, and the Cronbach's α is 0.962, which is greater than 0.7, indicating that the reliability of the measurement scale of corporate performance is good.

Table 4-6 the CITC and Cronbach's a coefficient of corporate performance

	Scale average after removal of items	Scale variance after deletion	CITC	Cronbach coefficient after item deletion	Cronbach's a coefficient （N=14）
VCF1	70.111	344.229	0.744	0.961	0.962
VCF2	70.317	348.93	0.638	0.963	
VCF3	70.175	342.985	0.729	0.961	
VCF4	70.413	344.44	0.701	0.961	

VCF5	70.286	345.53	0.711	0.961
VCS1	69.921	333.977	0.897	0.957
VCS2	69.841	340.039	0.806	0.959
VCS3	70.317	332.027	0.797	0.96
VCS4	70.079	333.397	0.864	0.958
VCS5	70.206	332.263	0.868	0.958
VCS6	70.079	332.913	0.877	0.958
VCS7	69.841	334.878	0.88	0.958
VCS8	69.968	338.063	0.852	0.958
VCS9	70.254	345.096	0.677	0.962

(4) Reliability analysis of entrepreneurship orientation

The CITC method, combined with Cronbach's coefficient, was used to purify the entrepreneurial-oriented scale. The specific results are shown in Table 4-7. It can be seen that the CITC values of all items are greater than 0.3, and the Cronbach's α coefficient is 0.951, which is greater than 0.7, indicating that the entrepreneurial oriented measurement scale has good reliability.

Table 4-7 the CITC and Cronbach's a coefficient of entrepreneurship orientation

	Scale average after removal of items	Scale variance after deletion	CITC	Cronbach coefficient after item deletion	Cronbach's a coefficient （N=14）
EOI1	73.714	277.111	0.782	0.947	0.951
EOI2	74.19	268.931	0.762	0.947	
EOI3	74.429	270.797	0.738	0.948	
EOI4	74.952	272.272	0.745	0.948	
EOI5	73.857	276.544	0.799	0.947	
EOI6	74.032	270.999	0.799	0.946	
EOP1	74.524	271.899	0.785	0.947	
EOP2	74.317	274.962	0.793	0.947	
EOP3	74.333	275.968	0.802	0.947	
EOP4	74.016	281.629	0.788	0.947	
EOP5	74.381	283.465	0.582	0.952	
EOR1	74.952	275.562	0.627	0.951	
EOR2	74.905	269.378	0.758	0.948	
EOR3	74.841	272.652	0.742	0.948	

(5) Reliability analysis of absorbing capacity

The method of CITC and the Cronbach coefficient were used to purify the scale of absorptive capacity. The specific results are shown in Table 4-8. It can be seen that the

CITC value of all items is greater than 0.3, the Cronbach's α coefficient is 0.909, which is greater than 0.7, showing that the measurement scale of absorptive capacity is good.

Table 4-8 the CITC and Cronbach's a coefficient of absorbing capacity

	Scale average after removal of items	Scale variance after deletion	CITC	Cronbach coefficient after item deletion	Cronbach's a coefficient （N=21）
Acq1	116.159	340.103	0.605	0.904	0.909
Acq2	116.286	341.046	0.556	0.905	
Acq3	117.254	329.87	0.459	0.909	
Acq4	118.714	334.369	0.411	0.91	
Acq5	116.508	327.867	0.644	0.903	
Acq6	116.587	328.02	0.637	0.903	
Ass1	117.762	338.378	0.376	0.91	
Ass2	116.127	340.629	0.659	0.904	
Ass3	116.238	334.765	0.742	0.902	
Tran1	116.127	332.79	0.742	0.901	
Tran2	115.952	338.401	0.704	0.903	
Tran3	116.095	336.217	0.687	0.903	
Tran4	118.603	338.405	0.381	0.91	
Tran5	117.063	335.318	0.517	0.906	
Tran6	116.444	333.961	0.594	0.904	
Exp1	116.048	340.143	0.637	0.904	
Exp2	118.81	335.931	0.376	0.911	
Exp3	115.905	340.539	0.638	0.904	
Exp4	115.952	335.336	0.699	0.902	
Exp5	117.508	337.641	0.424	0.909	
Exp6	116.238	335.442	0.670	0.903	

(6) Overall analysis

Overall, the reliability of the five variables of external knowledge, collaborative innovation, enterprise performance, entrepreneurship orientation and absorptive capacity is better, and the results are summarized in Table 4-9. It can be seen that, in addition to the overall reliability of the five variables, the reliability of the fractal dimension of each variable is better. Specifically, the reliability of the three dimensions of external knowledge is above 0.9, the reliability of the exploratory collaborative innovation and the exploitative collaborative innovation dimension is above 0.9, the growth and profitability dimensions of enterprise performance are above 0.95, and the three dimensions of entrepreneurship-oriented, innovation, risk-taking and proactive are above 0.9. For absorptive capacity, besides the poor reliability of the digestive ability dimension, the

other three dimensions are above 0.7. To sum up, the reliability of the scale involved these variables is good, which shows that the questionnaire has high internal consistency, and the analysis of the data collected by the questionnaire can well reflect the actual situation of the enterprise.

Table 4-9 the overall analysis of reliability

Variable		Cronbach's Alpha	The number of items	a values for the whole
External knowledge	direct access	0.936	5	0.981
	external cooperation	0.973	11	
	the flow of talent	0.969	6	
	knowledge sharing	0.983	9	
Collaborative innovation	exploratory collaborative innovation	0.943	7	0.962
	exploitative collaborative innovation	0.960	7	
Corporate performance	Growth	0.976	9	0.962
	Profitability	0.972	5	
Entrepreneurship orientation	Innovation	0.936	6	0.951
	risk-taking	0.904	3	
	Proactiveness	0.905	5	
absorbing capacity	acquisition capacity	0.781	6	0.909
	assimilate ability	0.498	3	
	transformation ability	0.767	6	
	application ability	0.717	6	

4.2.3 Validity Analysis

For the validity analysis of small sample data, we usually use the exploratory factor analysis to test the structural dimensions of the measurement scale and delete invalid measurement problem items. Exploratory factor analysis is mainly through principal component analysis and maximum variance method to obtain the factors to be studied. Generally, exploratory factor analysis can be judged by the value of KMO and Bartlett sphere test. The basic conditions for exploratory factor analysis are shown in Table 4-10:

Table 4-10 the conditions for exploratory factor analysis

KMO	Suitable for factor analysis
KMO<0.6	Unsuited
0.6<KMO<0.7	barely fit
0.7<KMO<0.8	Fit
0.8<KMO<0.9	very suitable
KMO>0.9	Perfect

(1) The exploratory factor analysis of external knowledge

Factor analysis of 22 problem items of knowledge acquisition produced 3 common factors. The results are shown in Table 4-11. The cumulative interpretation variance is 83.806%, which is consistent with the research hypothesis. The 22 items of knowledge acquisition are packaged into 3 items, respectively CFIntn, CFExtn, CFAcad, and then the factor analysis is carried out together with the knowledge sharing. The results are as follows.

Table 4-11 the results of factor analysis of knowledge acquisition

The name of factors	items	The loading of factor	KMO	cumulative explanatory variance (%)
direct access	CFIntn1	0.749	0.89	83.806
	CFIntn2	0.767		
	CFIntn3	0.701		
	CFIntn4	0.672		
	CFIntn5	0.742		
external cooperation	CFExtn1	0.738		
	CFExtn2	0.721		
	CFExtn3	0.643		
	CFExtn4	0.735		
	CFExtn5	0.732		
	CFExtn6	0.650		
	CFExtn7	0.703		
	CFExtn8	0.757		
	CFExtn9	0.598		
	CFExtn10	0.618		
	CFExtn11	0.815		
the flow of talent	CFAcad1	0.637		
	CFAcad2	0.72		
	CFAcad3	0.861		
	CFAcad4	0.843		
	CFAcad5	0.853		
	CFAcad6	0.823		

The KMO and Bartlett sphericity tests were performed first, the result is showed in Table 4-12. The value of KMO of the external knowledge scale is 0.888, which is greater than 0.7. The chi-square statistical value of the Bartlett spherical test is not significant, so the factor analysis can be carried out.

Table 4-12 the results of KMO and Bartlett tests

KMO		0.888
the Bartlett spherical test	Approximate Chi-Square	1319.503
	Degree of freedom	66
	significance	0.00

As can be seen from Table 4-13, the overall variance explanation table, there are 2 factors with characteristic roots greater than 1. The characteristic values are 9.058 and 1.631 respectively, and the cumulative explained variance variation is 89.078%. These results indicate that 2 factors can be extracted from external knowledge, which is consistent with the division of external knowledge into two dimensions in this study. From the rotated component matrix table 4-14, it can be seen that the load coefficient of each item in the factor is greater than 0.5, indicating that the structural validity of the external knowledge scale is better. The two dimensions of external knowledge are named knowledge acquisition and knowledge sharing.

Table 4-13 the total variance interpretation table

Component	Initial eigenvalue			Extract the square sum of the load		
	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %
1	9.058	75.484	75.484	9.058	75.484	75.484
2	1.631	13.594	89.078	1.631	13.594	89.078
3	0.505	4.21	93.287			
4	0.262	2.18	95.467			
5	0.191	1.589	97.056			
6	0.082	0.682	97.738			
7	0.073	0.605	98.342			
8	0.064	0.531	98.873			
9	0.047	0.395	99.268			
10	0.047	0.388	99.656			
11	0.032	0.264	99.92			
12	0.01	0.08	100.00			
Extraction method: principal component analysis.						

Table 4-14 the rotating composition matrix

	component	
	1	2
KS1	0.900	

KS2	0.936	
KS3	0.928	
KS4	0.944	
KS5	0.935	
KS6	0.919	
KS7	0.946	
KS8	0.933	
KS9	0.888	
CFIntn	0.587	0.720
CFExtn	0.674	0.703
CFAcad	0.612	0.700

Extraction method: principal component analysis.
2 components have been extracted.

(2) The exploratory factor analysis of collaborative innovation

The 14 items of collaborative innovation were tested by KMO and Bartlett spherical test, and the KMO of collaborative innovation measurement scale was 0.863, which is greater than 0.7. The chi-square statistical value of Bartlett spherical test was not significant, so factor analysis could be carried out. The result is shown in table 4-15.

Table 4-15 the results of KMO and Bartlett tests

KMO		0.863
the Bartlett spherical test	Approximate Chi-Square	1095.731
	Degree of freedom	91
	significance	0.00

It can be seen from Table 4-16 that there are two factors with characteristic roots greater than 1. The characteristic values are 9.426 and 1.623 respectively, and the cumulative explained variance variation is 78.922%. These results show that collaborative innovation can extract two factors, which is consistent with the two dimensions of collaborative innovation in this study. From the rotating composition matrix table (Table 4-17), it can be seen that the load coefficient of each item is greater than 0.5, which indicates that the structural validity of the collaborative innovation scale is better. The two dimensions are named exploratory collaborative innovation and exploitative collaborative innovation.

Table 4-16 the total variance interpretation table

Component	Initial eigenvalue			Extract the square sum of the load			Square of rotational load		
	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %
1	9.426	67.327	67.327	9.426	67.327	67.327	5.889	42.065	42.065
2	1.623	11.596	78.922	1.623	11.596	78.922	5.16	36.857	78.922
3	0.844	6.025	84.948						
4	0.601	4.291	89.239						
5	0.357	2.55	91.789						
6	0.276	1.97	93.759						
7	0.207	1.48	95.239						
8	0.164	1.169	96.408						
9	0.147	1.052	97.46						
10	0.116	0.828	98.288						
11	0.097	0.691	98.979						
12	0.07	0.501	99.48						
13	0.045	0.318	99.798						
14	0.028	0.202	100						

Extraction method: principal component analysis.

Table 4-17 the rotating composition matrix

Component		
	1	2
Expr1		0.839
Expr2		0.88
Expr3	0.352	0.821
Expr4		0.873
Expr5	0.545	0.699
Expr6	0.320	0.731
Expr7	0.540	0.628
Expo1	0.771	0.419
Expo2	0.876	0.361
Expo3	0.881	
Expo4	0.783	0.380
Expo5	0.892	0.326
Expo6	0.767	0.389
Expo7	0.848	

Extraction method: principal component analysis.
Rotary method: Kaiser standardized maximum variance method.
a rotation has converged after 3 iterations.

(3) The exploratory factor analysis of enterprise performance

Table 4-18 shows the result of KMO and Bartlett spherical test of 14 items of enterprise performance. The KMO value of measurement scale of enterprise performance is 0.894, which is greater than 0.7. The chi-square statistical value of Bartlett spherical test is not significant, so the factor analysis can be carried out.

Table 4-18 the results of KMO and Bartlett tests

KMO		0.894
the Bartlett spherical test	Approximate Chi-Square	1300.418
	Degree of freedom	91
	significance	0.00

As can be seen from Table 4-19, the overall variance explanation table, there are 2 factors with characteristic roots greater than 1. The characteristic values are 9.494 and 2.664 respectively, and the cumulative explained variance variation is 86.841%. These results indicate that 2 factors can be extracted from enterprise performance, which is consistent with the division of enterprise performance into two dimensions in this study. From the rotated component matrix table 4-20, it can be seen that the load coefficient of each item in the factor is greater than 0.5, indicating that the structural validity of the enterprise performance scale is better. The two dimensions of enterprise performance are named growth and profitability.

Table 4-19 the total variance interpretation table

Component	Initial eigenvalue			Extract the square sum of the load			Square of rotational load		
	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %	aggregate	variance percentage	Accumulate %
1	9.494	67.812	67.812	9.494	67.812	67.812	7.292	52.087	52.087
2	2.664	19.028	86.841	2.664	19.028	86.841	4.866	34.754	86.841
3	0.415	2.961	89.802						
4	0.345	2.467	92.269						
5	0.241	1.719	93.988						
6	0.161	1.15	95.139						
7	0.153	1.096	96.235						
8	0.151	1.081	97.316						
9	0.117	0.833	98.149						

10	0.082	0.587	98.736						
11	0.06	0.425	99.161						
12	0.053	0.376	99.537						
13	0.037	0.264	99.800						
14	0.028	0.2	100						

Extraction method: principal component analysis.

Table 4-20 the rotating composition matrix

Component		
	1	2
VCF1		0.906
VCF2		0.904
VCF3		0.934
VCF4		0.922
VCF5		0.908
VCS1	0.902	0.321
VCS2	0.861	
VCS3	0.836	
VCS4	0.885	
VCS5	0.800	0.415
VCS6	0.916	
VCS7	0.923	
VCS8	0.938	
VCS9	0.851	

Extraction method: principal component analysis.
Rotary method: Kaiser standardized maximum variance method.
a rotation has converged after 3 iterations.

(4) The exploratory factor analysis of entrepreneurship orientation

The exploratory factor analysis was carried out on 14 problem items of entrepreneurship orientation, and the KMO value was 0.842, which can be used for factor analysis.

It can be seen from Table 4-21 that there are three factors with characteristic roots greater than 1, the characteristic values are 7.866, 1.45 and 1.007 respectively, and the cumulative explained variance variation is 86.021%. These results show that entrepreneurship orientation can extract three factors, which is consistent with our hypothesis. From the rotating component matrix table (Table 4-22), we can see that the load coefficient of each item is greater than 0.5, indicating that the structural validity of the entrepreneurship orientation scale is better. The three dimensions are named innovation, risk-taking and proactiveness.

Table 4-21 the total variance interpretation table

Component	Initial eigenvalue			Extract the square sum of the load			Square of rotational load		
	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %
1	7.866	65.549	65.549	7.866	65.549	65.549	4.303	35.862	35.862
2	1.45	12.081	77.63	1.45	12.081	77.63	3.328	27.734	63.596
3	1.007	8.391	86.021	1.007	8.391	86.021	2.691	22.425	86.021
4	0.503	4.193	90.214						
5	0.285	2.378	92.591						
6	0.23	1.914	94.505						
7	0.196	1.631	96.136						
8	0.154	1.284	97.42						
9	0.111	0.925	98.344						
10	0.088	0.737	99.082						
11	0.067	0.561	99.643						
12	0.043	0.357	100						

Extraction method: principal component analysis.

Table 4-22 the rotating composition matrix

Component			
	1	2	3
EOI1	0.804	0.312	
EOI2	0.852	0.362	
EOI3	0.769	0.309	
EOI4	0.500		
EOI5	0.882		
EOI6	0.876	0.302	
EOP1	0.327	0.757	0.356
EOP2	0.359	0.867	
EOP3	0.362	0.869	
EOP4	0.380	0.726	0.338
EOP5		0.501	
EOR1		0.374	0.865
EOR2	0.385		0.804
EOR3	0.366		0.846

Extraction method: principal component analysis.
Rotary method: Kaiser standardized maximum variance method.

(5) The exploratory factor analysis of absorbing capacity

The factor analysis is carried out on 21 problem items of absorptive capacity, and the KMO value is 0.811, which can be used for factor analysis.

As can be seen from table 4-23, there are four factors with a characteristic root greater than 1, the eigenvalues are 9.373, 3.385, 2.148 and 1.134 respectively, the cumulative variance was 76.386%. These results show that the absorptive capacity can extract four factors, which is consistent with the four dimensions of absorptive capacity in this study. From the rotating composition matrix table (Table 4-24), it can be seen that the load coefficients of each item in the factor are greater than 0.5, suggesting that the structural validity of the absorptive capacity scale is better. The four dimensions are named acquisition ability, digestion ability, transformation ability and application ability.

Table 4-23 the total variance interpretation table

Component	Initial eigenvalue			Extract the square sum of the load			Square of rotational load		
	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %	aggregate	variance percentage	accumulate %
1	9.373	44.635	44.635	9.373	44.635	44.635	7.318	34.847	34.847
2	3.385	16.12	60.754	3.385	16.12	60.754	3.686	17.551	52.398
3	2.148	10.23	70.984	2.148	10.23	70.984	3.022	14.388	66.786
4	1.134	5.402	76.386	1.134	5.402	76.386	2.016	9.6	76.386
5	0.982	4.677	81.063						
6	0.8	3.81	84.873						
7	0.558	2.656	87.529						
8	0.544	2.589	90.118						
9	0.42	2	92.118						
10	0.332	1.582	93.7						
11	0.23	1.095	94.795						
12	0.208	0.991	95.786						
13	0.182	0.865	96.651						
14	0.176	0.837	97.488						
15	0.146	0.696	98.184						
16	0.097	0.464	98.649						
17	0.088	0.418	99.067						
18	0.073	0.347	99.414						
19	0.061	0.289	99.703						
20	0.043	0.206	99.909						
21	0.019	0.091	100						

Extraction method: principal component analysis

Table 4-24 the rotating composition matrix

Component				
	1	2	3	4
Acq1	0.71	0.413		
Acq2	0.867			
Acq3	0.508			0.596
Acq4	0.889			
Acq5	0.836	0.351		
Acq6	0.863	0.341		
Ass1			0.755	
Ass2			0.883	
Ass3			0.895	
Tran1	0.435	0.749		
Tran2		0.856		
Tran3		0.765		0.35
Tran4		0.764		0.356
Tran5	0.395	0.71		
Tran6		0.584		
Exp1				0.91
Exp2				0.831
Exp3				0.906
Exp4				0.854
Exp5			0.389	0.814
Exp6				0.801

Extraction method: principal component analysis.
rotation method: Kaiser standardized maximum variance method until convergence.

4.3 Data collection

The sampling frame of this study consisted of firms located in the Science and Technology Parks. The random sampling method was used to select 500 firms. Following Dillman's (2000) total design method, the questionnaire with an invitation letter were sent by postal mail, email, and in person to the CEOs or top managers of the participating firms. The invitation letter explained the purpose of the study, the approximate time for completing the survey, and the basic ethics involved in this research. In addition, to reduce any possible desirability bias, the letter promised the confidentiality of all information provided by participants. Finally, 268 available questionnaires were collected. The above questionnaires were mainly from enterprises in science and Technology Parks in Fujian Province, Guangdong Province and Zhejiang Province. Each questionnaire corresponds

to an enterprise in the above science and technology parks. And The information of the above sample enterprises is described in Chapter 5.

4.4 Measurement of Variables

This section describes the scale items that were used to measure the research constructs in this study. 7-point Likert Scales, ranging from (1= Strongly Disagree) to (7= Strongly Agree) were selected to assess the measurement.

4.4.1 Measurement of External Knowledge

The behavior of knowledge acquisition is part of knowledge management, which is defined as "a critical process of knowledge management to meet existing needs to identify, expand existing and needed knowledge assets and develop new opportunities". At present, there are many studies have showed that external knowledge has a significant impact on enterprise performance and have described the multiple paths of knowledge acquisition. In general, the sources of external knowledge acquisition can be divided into the following three categories: the direct external knowledge acquisition, cooperation with external organizations and the flow of talent.

The direct acquisition of external knowledge refers to the conscious search of knowledge needed by enterprises through various means. This knowledge includes: the learning of a product, process, enterprise; the mastery of the overall market, technology, policy status and trends; the mastery of professional knowledge of various management and technology. It is an important way of acquiring external knowledge to establish formal and informal collaboration and association with external organizations. Through the efficient cooperative learning, organizations involved in cooperation can benefit a lot, especially in innovative enterprises. Through the cooperation between organizations, enterprises can not only directly acquire explicit knowledge, that is, the results of research & development and cooperation, but also spread all kinds of Inexpressible knowledge among enterprises through the contact and exchange between enterprise personnel. The third is the flow of talents, which is an important means for enterprises to acquire external knowledge. Obtaining the knowledge needed of enterprises through the flow of talents, we can directly avoid the obstacles of knowledge transfer between organizations. Therefore, the variable of knowledge acquisition is measured from three aspects: direct

acquisition, cooperation with external organizations and talent flow. The relevant measurement items are shown in Table 4-25.

Table 4-25 the initial measurement scale for knowledge acquisition

	code	Items
CFIntn	CFIntn1	Enterprises acquire knowledge through employee blogs and forms
	CFIntn2	Enterprises acquire knowledge through employee social media networks
	CFIntn3	Enterprises acquire knowledge through employee focus groups
	CFIntn4	Enterprises acquire knowledge through employee councils
	CFIntn5	Enterprises acquire knowledge through product marketing team
CFExtn	CFExtn1	Enterprises acquire knowledge through blogs intended for lead users
	CFExtn2	Enterprises acquire knowledge through online forums for customers
	CFExtn3	Enterprises acquire knowledge through competitions and ideation contests
	CFExtn4	Enterprises acquire knowledge through private label social media networks intended for lead users/customers
	CFExtn5	Enterprises acquire knowledge through social media networks intended for lead users/customers
	CFExtn6	Enterprises acquire knowledge through crowdsourcing intermediaries/platforms (such as Iingdong website)
	CFExtn7	Enterprises acquire knowledge through consumer focus groups/other market research
	CFExtn8	Enterprises acquire knowledge through direct feedback from consumers and lead users (e.g., customer service calls)
	CFExtn9	Enterprises acquire knowledge through offline open innovation communities
	CFExtn10	Enterprises acquire knowledge through offline predictive models
	CFExtn11	Enterprises acquire knowledge through customers by sales teams
CFAcad	CFAcad1	Enterprises acquire knowledge through individual networks with university employees
	CFAcad2	Enterprises acquire knowledge through an effort to retain academic (e.g., professors, postgraduate students, etc.)
	CFAcad3	Enterprises acquire knowledge through accessing to knowledge of academic staff
	CFAcad4	Enterprises acquire knowledge through co-authorship with academic staff
	CFAcad5	Enterprises acquire knowledge through partnership with mission labs in universities
	CFAcad6	Enterprises acquire knowledge through scientific collaboration

The knowledge sharing in this study refers to the process of exchanging and sharing experience, transmitting, internalizing and absorbing knowledge between enterprises and partners. Through sharing knowledge, enterprises can apply knowledge well in order to

internalize and absorb its knowledge well. Take the following indicators of table 4-26 to measure the level of knowledge sharing in enterprises.

Table 4-26 the initial measurement scale for knowledge sharing

	Code	Items
Knowledge Sharing	KS1	Our firm shares our innovation work reports and technical documents to collaborators at their request
	KS2	Our firm shares our manuals and methodologies to our suppliers or customers at their request
	KS3	Our firm shares our experience, know-how, or new ideas from innovation work with collaborators at their request
	KS4	Our firm shares knowledge with the collaborative project team to increase efficiency levels
	KS5	Our firm share knowledge with the collaborative project team to realize cost savings
	KS6	Our firm shares knowledge with the project collaborative team to reduce consumption of materials or resources
	KS7	Our firm shares knowledge with the collaborative project team to generate new services
	KS8	Our firm shares knowledge with the collaborative project team to open up new markets
	KS9	Our firm shares knowledge with the collaborative project team to enter and/or apply new technologies

4.4.2 Measurement of Collaborative Innovation

Collaborative innovation refers to the ability of enterprises to maintain innovation by sharing knowledge and technology. The government, enterprises and universities work together to achieve innovation and ultimately realize value increment and creation. The existing studies have confirmed the dynamic synergy between technological innovation and management innovation. On the one hand, studies have confirmed the impact of management innovation on technological innovation. Vickery et al (1999) noted that management innovation can affect the efficiency of technological innovation and can provide organizational support for technological innovation activities; On the other hand, some studies have confirmed that technological innovation has an impact on management

innovation. Technological innovation can help enterprises to implement management changes. Xu et al. (2004) believed that technological innovation belongs to the category of productivity, while management innovation belongs to production relations and there is a dialectical synergy between them. To clarify the synergies of innovation ambidexterity, this thesis divides collaborative innovation into exploitative collaboration innovation and exploration collaborate innovation.

According to the theory of organizational ambidexterity, in an increasingly competitive environment, enterprises need to use existing knowledge to consolidate existing markets, it is also necessary to implement new technologies to improve the speed of response to the market. Therefore, enterprises need to make full use of exploitative and exploration innovation to improve innovation performance. The exploitative collaboration innovation is based on the existing knowledge and capabilities of the enterprise, meeting the needs of corporate customers by improving existing technology and knowledge and expanding product lines, which innovation risk is small; In the same way, the exploratory collaboration innovation meets the market demands through improving operational efficiency by optimizing existing systems and structures. Referring to the studies of Jansen et al (2006) and He et al (2004), exploratory collaborative innovation and exploitative collaborative innovation are measured by seven items respectively, the relevant measurement items are shown in Table 4-27.

Table 4-27 the initial measurement scale for collaborative innovation

	code	Items
exploratory collaborative innovation	Expr1	Accepts demands that go beyond existing products and services
	Expr2	Invents new products and services
	Expr3	Experiments with new products and services in our local market
	Expr4	Commercializes products and services that are completely new to our firm
	Expr5	Frequently utilizes new opportunities in new markets
	Expr6	Regularly uses new distribution channels
	Expr7	Regularly searches for and approach new clients in new markets
exploitative collaborative innovation	Expo1	Frequently refines the provision of existing products and services
	Expo2	Regularly implements small adaptations to existing products and Services
	Expo3	Introduces improved, but existing products and services for our local market
	Expo4	Improves our provisions' efficiency of products and services
	Expo5	Increases economies of scales in existing markets
	Expo6	Expands services for existing clients
	Expo7	Lowering costs of internal processes is an important objective in our firm

4.4.3 Measurement of Enterprise Performance

In the development of the measurement scale of enterprise performance, we mainly draw lessons from the two-dimensional measurement scale including growth performance and financial indicators of Venkatraman (1989)、Lumpkin and Dess (1996), Shen and Luo's (2006) four-dimensional measurement scale of finance, customer, internal operation and employee. The relevant measurement options are shown in Table 4-28.

Table 4-28 the initial measurement scale for enterprise performance

	code	Items
profitability	VCF1	Achieved sales growth
	VCF2	Achieved growth in return on investment (ROI)
	VCF3	Achieved growth in return on sales (ROS)
	VCF4	Achieved growth in return on equity (ROE)
	VCF5	Achieved growth in market share
growth	VCS1	Compared with the same industry, our company develops new products faster
	VCS2	Compared with the same industry, our product innovation success rate is higher
	VCS3	Compared with the industry, we have more patents and research and development
	VCS4	Compared with the same industry, our company has developed more new products
	VCS5	Compared with the same industry, our company's new product sales accounted for a larger proportion of total revenue
	VCS6	Our company often leads the industry in applying new technologies
	VCS7	Our company's new product improvement and innovation has a good market response
	VCS8	Our products contain first-class technology
	VCS9	It is difficult for similar products in the industry to replace our innovative products

4.4.4 Measurement of Absorptive Capacity

The measurement of absorptive capacity has experienced the process from the single variable measurement of static structure view to the multi-dimensional measurement of dynamic process view. The structural view regards absorptive capacity as a part of previous experience, the intensity of R&D or the number of patents is usually selected as the single measure of absorptive capacity. The process view is not limited to the previous experience, which sees absorptive capacity as a dynamic capability and process. The absorptive capacity is the ability and process of the organization to recognize, evaluate, assimilate, transform, integrate and apply external knowledge (Kogut et al., 1992; Nonaka,

1994; Lane et al.,2006). Here, it is measured from four aspects: acquisition ability, assimilate ability, transformation ability and application ability, the specific measurement items are shown Table 4-29.

Table 4-29 the initial measurement scale for absorptive capacity

	code	Item
acquisition ability	Acq1	our top management and core-knowledge employees have frequent interactions with other companies in the industry to acquire new knowledge
	Acq2	our top management and core-knowledge employees regularly visit other companies
	Acq3	our top management and core-knowledge employees collect industry information through informal means(e.g., lunch with industry friends, talks with trade partners)
	Acq4	our top management and core-knowledge employees hardly visit other firms within this industry
	Acq5	our top management and core-knowledge employees periodically have special meetings with customers or third parties
	Acq6	our top management and core-knowledge employees regularly approach third parties
assimilate ability	Ass1	our top management and core-knowledge employees are slow to recognize shifts in our market
	Ass2	our top management and core-knowledge employees quickly understand new opportunities to serve our clients
	Ass3	our top management and core-knowledge employees quickly analyze and interpret changing market demands
transformation ability	Tran1	our top management and core-knowledge employees regularly consider the consequences of changing market demands in terms of new products and services
	Tran2	our top management and core-knowledge employees record and store newly acquired knowledge for future reference
	Tran3	our top management and core-knowledge employees quickly recognizes the usefulness of new external knowledge to existing knowledge
	Tran4	our top management and core-knowledge employees hardly share practical experiences
	Tran5	our top management and core-knowledge employees laboriously grasp the opportunities from new external knowledge.
	Tran6	our top management and core-knowledge employees periodically meets to discuss consequences of market trends and new product development
application ability	Exp1	our top management and core-knowledge employees clearly know how activities within this firm should be performed
	Exp2	our top management and core-knowledge employees turn a deaf ear on client complaints in this firm
	Exp3	our top management and core-knowledge employees have a clear division of roles and responsibilities

	Exp4	our top management and core-knowledge employees constantly consider how to better exploit knowledge
	Exp5	our top management and core-knowledge employees have difficulty implementing new products and services
	Exp6	our top management and core-knowledge employees have a common language regarding our products and services

4.4.5 Measurement of Entrepreneurship-oriented

Khandwalla (1977) has developed the first scale in regard to entrepreneurship-oriented, including two dimensions of advance and innovative, which broadens the research ideas and has far-reaching significance for the development of the three-dimensional and five-dimensional scale. Miller et al., (1982) were the first to construct the three-dimensional measurement scale of entrepreneurship orientation, which was developed based on the three levels of foresight, innovation and adventure divided by Miller's previous research. Thereafter, Miller (1983) put forward that the key to entrepreneurship-oriented enterprises lies in innovation. In addition, the innovation of products and services is often accompanied by the risk. At the same time, the enterprises taking these pre-adventure behaviors can defeat the opponent. The entrepreneurial behavior is closely related to the internal and external environment of the organization. Morris et al., (2003) proposed that organizational culture and human resource management are the key to entrepreneurship based on the influencing factors of entrepreneurial orientation within the organization. Covin et al., (1989) believed that the mutual adaptation of entrepreneurial orientation and internal structure will positively affect the performance of enterprises. Covin et al., (1991) explore the influence factors on enterprise entrepreneurship orientation from the view of the outside, inside and strategic direction of the organization, and find that organizational culture is a key role. The scale developed by Covin et al., (1991) has the largest scope of application, the results of this questionnaire show ideal stability and accuracy in various countries, industries and enterprises of different nature. Lumpkin et al., (1996) put forward the groundbreaking five-dimensional theory of entrepreneurship orientation, pointing out that organizational culture is an important influencing factor in the relationship between entrepreneurship orientation and enterprise performance. In addition, they explored the effect of two new dimensions of measurement in 2001 and 2009, which further points out that entrepreneurship orientation is not only included in corporate culture, but also its external manifestation. The current questionnaire of entrepreneurship-

oriented generally uses a three-dimensional scale developed by Covin et al., (1991), so this thesis also designs the entrepreneurial orientation scale on its basis. The specific items are shown in Table 4-30.

Table 4-30 the initial measurement scale for entrepreneurship-oriented

	code	Item
innovation	EOI1	Our firm places a strong emphasis on innovation
	EOI2	In the last three years, our firm has marketed many new, innovative service
	EOI3	In the last three years, changes in our products or services have been usually dramatic
	EOI4	Our firm provides leadership in developing new services
	EOI5	Our firm constantly experiments with new services
	EOI6	Our firm promotes new business models
proactiveness	EOP1	Our firm usually takes action in anticipation of future market Conditions
	EOP2	Our firm consistently try to position ourselves to meet emerging demands
	EOP3	Our firm seeks to exploit anticipated changes in our target market ahead of our rivals
	EOP4	Our firm seizes initiatives whenever possible in our target market operations
	EOP5	Our firm acts opportunistically to shape the business environment in which we operate
risk-taking	EOR1	Our firm, in general, has a strong proclivity for high-risk projects (with chances of high returns)
	EOR2	Due to the nature of the business environment, our firm takes bold, wide-ranging actions to achieve the firm's objectives
	EOR3	When confronted with decision-making situations involving uncertainty, our firm typically adopts a bold posture in order to maximize the probability of exploiting potential opportunities

5 RESULTS

This chapter consists of four sections. In the first section, I present the results of reliability and validity of the measurement model. The second section reports the results of descriptive statistics while third sections present the results of hypothesis testing. Finally, the results of hypothesis testing were summarized in Section 4.

5.1 Reliability and Validity Assessment

5.1.1 Reliability

SPSS 22.0 was used to test the reliability of the scale. As shown in Table 5-1, the overall reliability of each variable scale is above 0.9, and the reliability of each dimension of each scale is above 0.8. It can be inferred that the credibility of the whole scale is good and the questionnaire has high internal consistency. The data analysis of the questionnaire can accurately and reliably reflect the relation between of external knowledge, absorptive capacity, collaborative innovation, entrepreneurship orientation and enterprise performance.

Table 5-1 the analysis of reliability

Variable		Cronbach's Alpha	The number of items	the whole
External knowledge	knowledge acquisition	0.961	3	0.974
	knowledge sharing	0.988	9	
Collaborative innovation	exploratory collaborative innovation	0.972	7	0.978
	exploitative collaborative innovation	0.977	7	
Corporate performance	Growth	0.984	9	0.973
	Profitability	0.977	5	
Entrepreneurship orientation	Innovation	0.948	6	0.973
	risk-taking	0.952	3	
	Proactiveness	0.973	5	
absorbing capacity	acquisition capacity	0.841	6	0.952
	assimilate ability	0.779	3	
	transformation ability	0.859	6	
	application ability	0.831	6	

5.1.2 Validity

The structural validity can be verified by confirmatory factor analysis (CFA). Generally, it is considered that the value of CR is greater than 0.7, which indicates that the scale has

better aggregation validity, and the criterion of AVE is generally greater than 0.5. AVE indicates the total variance that the latent variable can explain relative to the measurement error. That is to say, how much of the variance explained by potential variables comes from measurement errors. A higher AVE indicates a higher level of interpretation by potential variables, at that time, the smaller the measurement error and the higher the aggregation validity.

5.1.2.1 Confirmatory Factor Analysis of External Knowledge

(1) the model setting of factors

External knowledge consists of two potential variables, knowledge acquisition and knowledge sharing, in which the latent variables of knowledge acquisition are composed of three measurement questions, and knowledge sharing includes nine measurement questions.

(2) the estimation of model parameter

The AMOS 24.0 is used to analyze the model. The measurement model is shown in figure 5-1. The chi-square degree of freedom ratio is 4.179 and the value of RMSEA is 0.109, the fitness of model is not particularly ideal, but it is still acceptable.

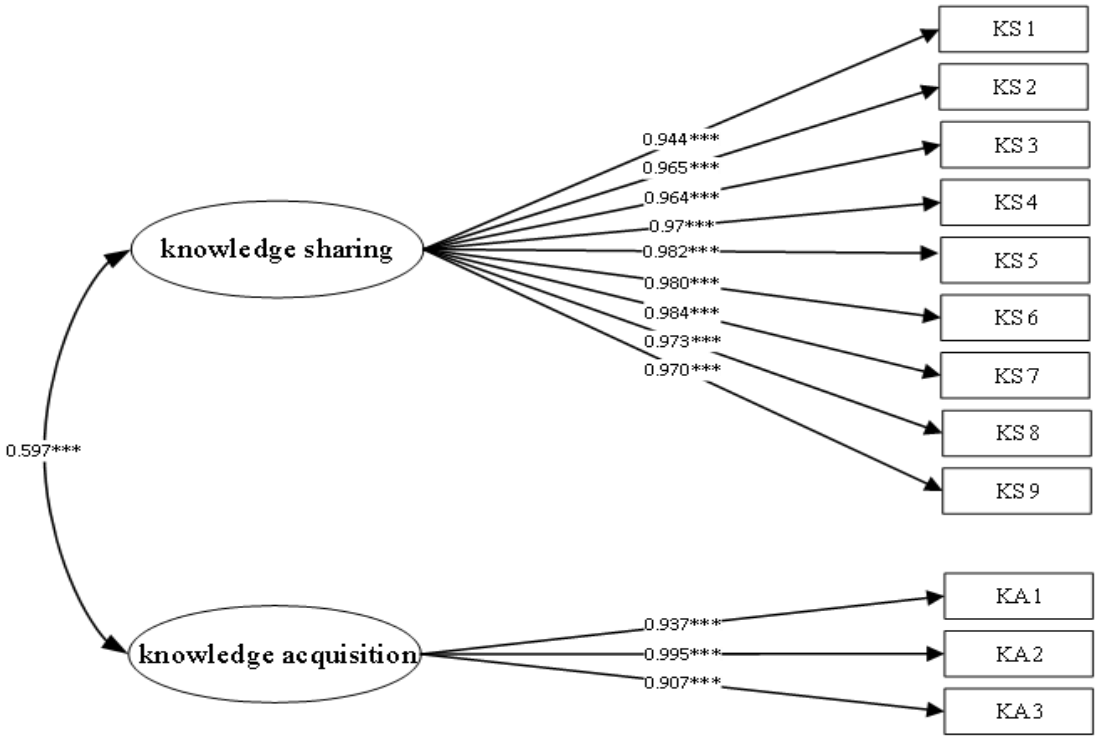

Figure 5-1 The measurement model of external knowledge

Table 5-2 can be obtained according to the results. The values of CR of knowledge acquisition and knowledge sharing were 0.948 and 0.993 respectively, which were greater than 0.7. AVE were 0.858 and 0.941 respectively, were greater than 0.5, indicating that the internal consistency of the two latent variables of external knowledge is high and the internal quality of the model is ideal.

Table 5-2 the confirmatory factor analysis of external knowledge

variable	item	factor loading	reliability	CR	AVE
knowledge acquisition	CFIntn	0.937	0.878	0.948	0.858
	CFExtn	0.995	0.990		
	CFAcad	0.907	0.823		
knowledge sharing	KS1	0.944	0.891	0.993	0.941
	KS2	0.965	0.931		
	KS3	0.964	0.929		
	KS4	0.97	0.941		
	KS5	0.982	0.964		
	KS6	0.98	0.960		
	KS7	0.984	0.968		
	KS8	0.973	0.947		
	KS9	0.97	0.941		

5.1.2.2 Confirmatory Factor Analysis of Collaborative Innovation

(1) the model setting of factors

Collaborative innovation consists of two potential variables, the exploratory collaborative innovation and the exploitative collaborative innovation, there are seven measurement questions respectively.

(2) the estimation of model parameter

The analysis of the model using AMOS 24.0, the measurement model is shown in figure 5-2, The chi-square degree of freedom ratio is 4.239. In order to increase the fit degree of the model, the correlation is added between e11 and e12, between e5 and e13, between e7 and e8, and between e4 and e8 according to the MI. After modifying the model, the chi-square degree of freedom ratio becomes 3.477, RMSEA to 0.096, the model is acceptable.

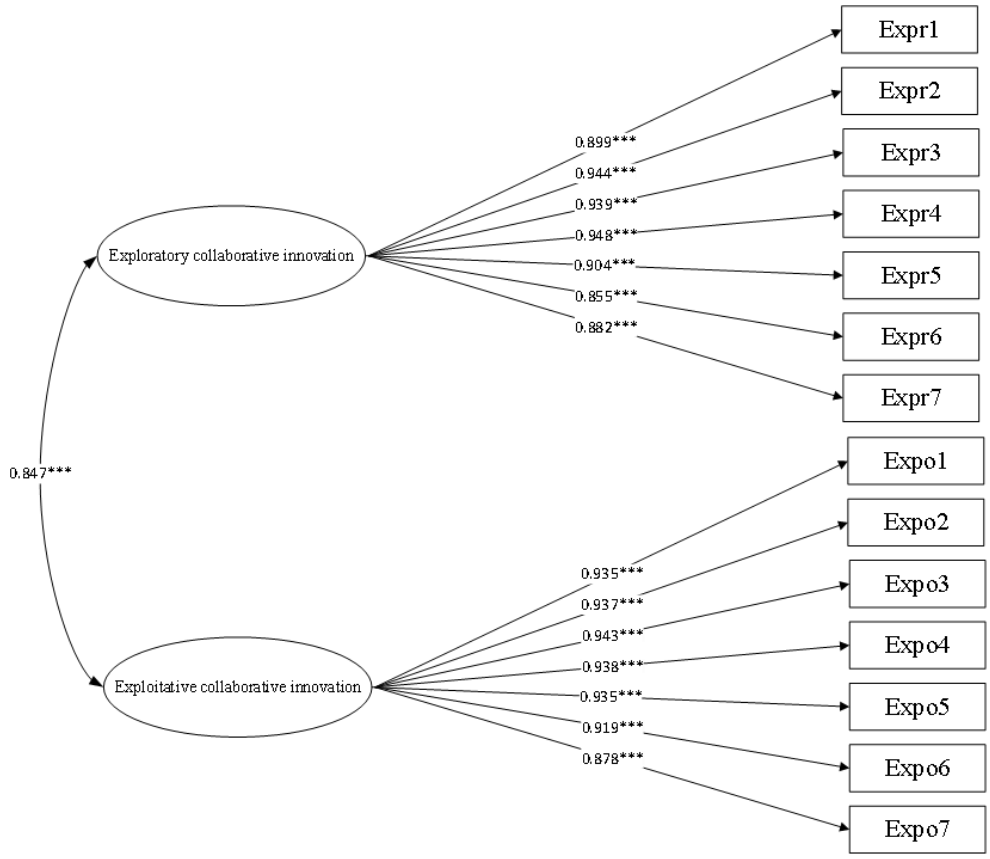

Figure 5-2 The measurement model of collaborative innovation

According to the results, the factor loads of each question are obtained. As shown in Table 5-3, the CR values of exploratory collaborative innovation and exploitative collaborative innovation are 0.971 and 0.977 respectively, both of which are greater than 0.7. AVE of 0.829 and 0.859, respectively, are greater than 0.5, indicating that the internal consistency of the two latent variables of collaborative innovation is high and the internal quality of the model is ideal.

Table 5-3 the confirmatory factor analysis of collaborative innovation

variable	item	factor loading	reliability	CR	AVE
exploratory collaborative innovation	Expr7	0.882	0.778	0.971	0.829
	Expr6	0.855	0.731		
	Expr5	0.904	0.817		
	Expr4	0.948	0.899		
	Expr3	0.939	0.882		
	Expr2	0.944	0.891		
	Expr1	0.899	0.808		
exploitative collaborative innovation	Expo7	0.878	0.771	0.977	0.859
	Expo6	0.919	0.845		
	Expo5	0.935	0.874		
	Expo4	0.938	0.880		

Expo3	0.943	0.889
Expo2	0.937	0.878
Expo1	0.935	0.874

5.1.2.3 Confirmatory Factor Analysis of Enterprise Performance

(1) the model setting of factors

The enterprise performance consists of two potential variables: growth and profitability. Growth includes 9 measurement questions and profitability includes 5 measurement questions.

(2) the estimation of model parameter

The analysis of the model using AMOS 24.0. The measurement model is shown in Figure 5-3. The chi-square degree of freedom ratio is 3.555 and the RMSEA value is 0.098. The model is acceptable.

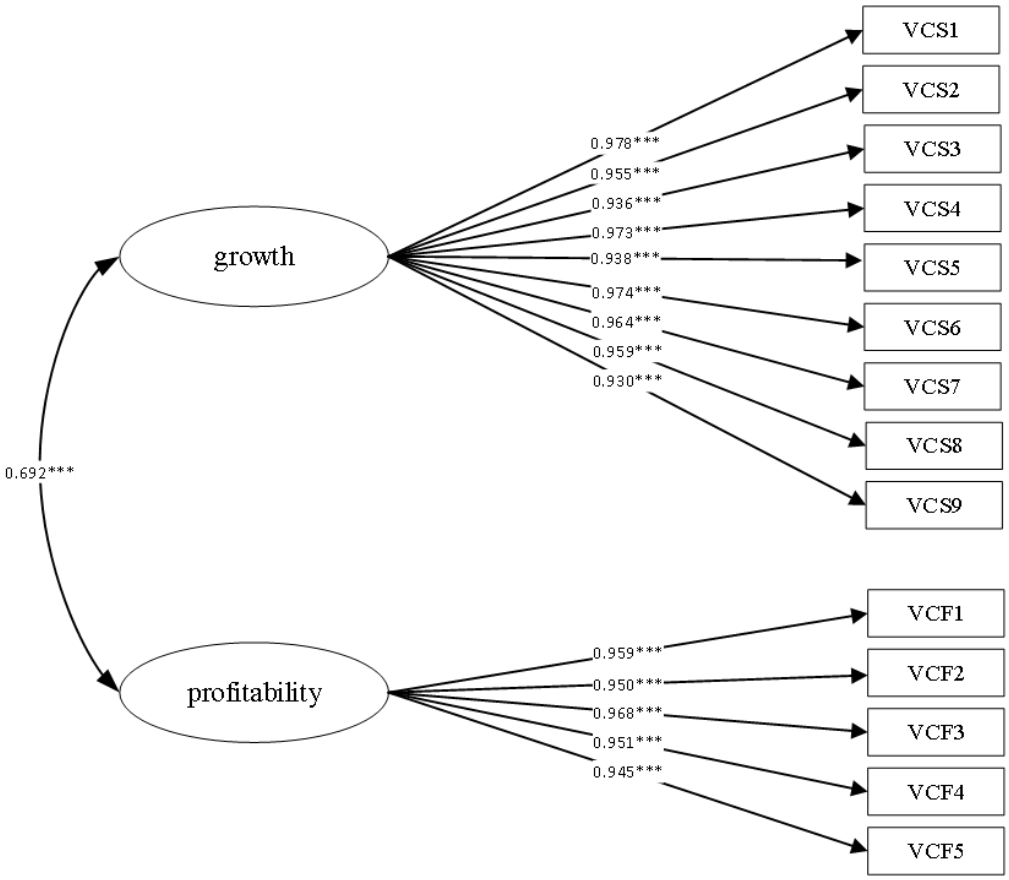

Figure 5-3 The measurement model of enterprise performance

According to the results, the factor loads of each item are obtained. As shown in Table 5-4, the CR values of growth and profitability are 0.990 and 0.961 respectively, both of which are greater than 0.7. AVE are 0.915 and 0.831 respectively, which is greater than

0.5, indicating that the internal consistency of the two latent variables of enterprise performance is high and the internal quality of the model is ideal.

Table 5-4 the confirmatory factor analysis of enterprise performance

variable	item	factor loading	reliability	CR	AVE
growth	VCS9	0.930	0.865	0.990	0.915
	VCS8	0.959	0.920		
	VCS7	0.964	0.929		
	VCS6	0.974	0.949		
	VCS5	0.938	0.880		
	VCS4	0.973	0.947		
	VCS3	0.936	0.876		
	VCS2	0.955	0.912		
	VCS1	0.978	0.956		
profitability	VCF5	0.945	0.893	0.961	0.831
	VCF4	0.951	0.904		
	VCF3	0.968	0.937		
	VCF2	0.950	0.903		
	VCF1	0.959	0.920		

5.1.2.4 Confirmatory Factor Analysis of Entrepreneurship Orientation

(1) the model setting of factors

Entrepreneurship orientation is composed of three potential variables: innovation, risk-taking, proactiveness，the innovation contains 6 items, risk-taking includes 3 items, and proactiveness includes 5 items.

(2) the estimation of model parameter

The AMOS 24.0 is used to analyze the model. The measurement model is shown in Figure 5-4. The chi-square degree of freedom ratio is 3.576 and the value of RMSEA is 0.098, the model is acceptable.

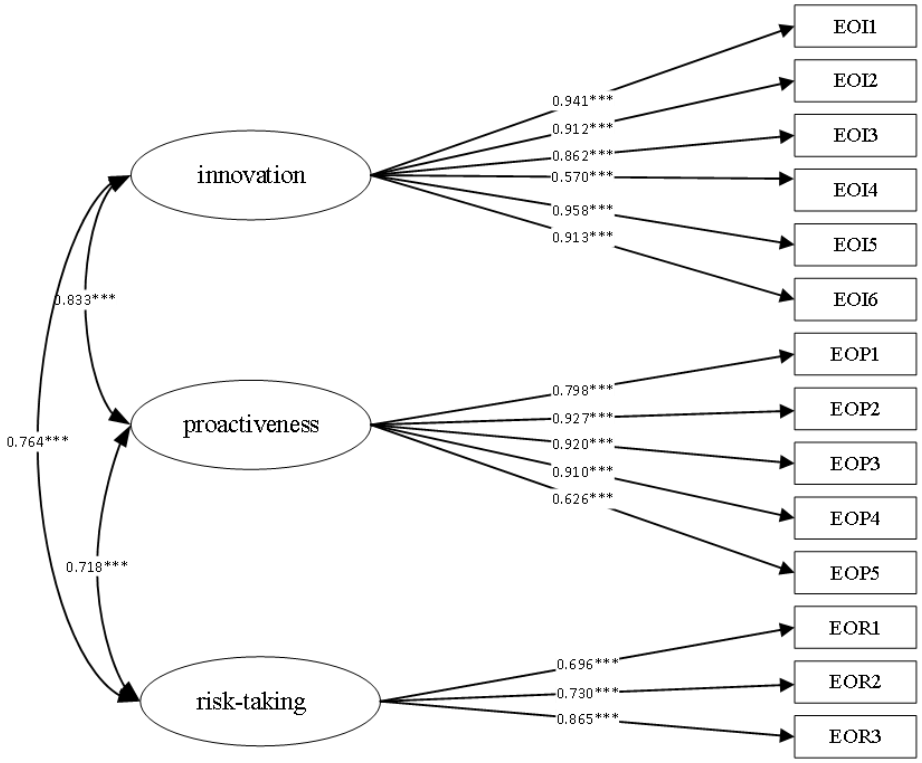

Figure 5-4 The measurement model of entrepreneurship orientation

The values of CR and AVE of each potential variable are calculated, and the results are shown in Table 5-5. CR values of innovation, risk-taking and proactiveness were 0.947, 0.924 and 0.810 respectively, all of which were greater than 0.7. AVE are 0.875, 0.712, 0.588, respectively, which indicates that the internal consistency of the three latent variables under the guidance of entrepreneurship is high and the internal quality of the model is ideal.

Table 5-5 the confirmatory factor analysis of entrepreneurship orientation

variable	item	factor loading	reliability	CR	AVE
innovation	EOI1	0.941	0.885	0.947	0.756
	EOI2	0.912	0.832		
	EOI3	0.862	0.743		
	EOI4	0.570	0.325		
	EOI5	0.958	0.918		
	EOI6	0.913	0.834		
Proactiveness	EOP1	0.798	0.637	0.924	0.712
	EOP2	0.927	0.859		
	EOP3	0.920	0.846		
	EOP4	0.910	0.828		
	EOP5	0.626	0.392		
risk-taking	EOR1	0.696	0.484	0.810	0.588

EOR2	0.730	0.533	
EOR3	0.865	0.748	

5.1.2.5 Confirmatory Factor Analysis of Absorbing Capacity

(1) the model setting of factors

Absorptive ability consists of four potential variables: acquisition ability, assimilate ability, transformation ability, application ability. The acquisition ability including 6 items, assimilate ability including 3 items, transformation ability including 6 items, application ability including 6 items.

(2) the estimation of model parameter

The AMOS 24.0 is used to analyze the model. The measurement model is shown in Figure 5-5. The chi-square degree of freedom ratio is 3.501 and the value of RMSEA is 0.097, the model fit is within the acceptable range.

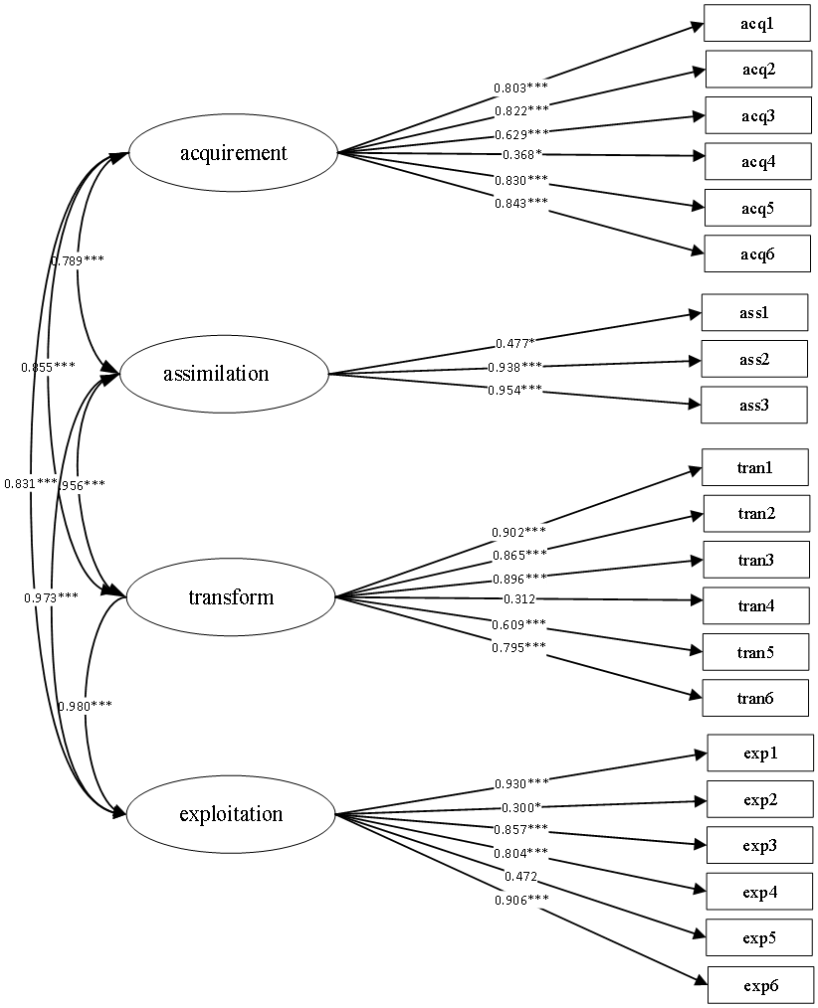

Figure 5-5 The measurement model of absorptive ability

The CR values and AVE values of each potential variable are calculated, and the results are shown in Table 5-6. CR values of acquisition ability, assimilation ability, transformation ability and application ability were 0.870, 0.851, 0.883, 0.874, respectively, all of which were greater than 0.7. AVE are 0.542, 0.672, 0.577, 0.563, all of which are greater than 0.5, indicating that the internal consistency of the four latent variables of absorptive capacity is high and the internal quality of the model is ideal.

Table 5-6 the confirmatory factor analysis of external knowledge

variable	item	factor loading	reliability	CR	AVE
acquisition ability	Acq6	0.843	0.711	0.870	0.542
	Acq5	0.830	0.689		
	Acq4	0.368	0.135		
	Acq3	0.629	0.396		
	Acq2	0.822	0.676		
	Acq1	0.803	0.645		
transformation ability	Tran6	0.795	0.632	0.883	0.577
	Tran5	0.609	0.371		
	Tran4	0.312	0.097		
	Tran3	0.896	0.803		
	Tran2	0.865	0.748		
	Tran1	0.902	0.814		
Application ability	Exp6	0.906	0.821	0.874	0.563
	Exp5	0.472	0.223		
	Exp4	0.804	0.646		
	Exp3	0.857	0.734		
	Exp2	0.300	0.090		
	Exp1	0.930	0.865		
assimilate ability	Ass3	0.954	0.910	0.851	0.672
	Ass2	0.938	0.880		
	Ass1	0.477	0.228		

5.2 Descriptive Analysis

5.2.1 the basic information of enterprises

The basic information of the enterprise is mainly investigated from the aspects of the industry, the legal status of the enterprise, the frequency of the interaction between the enterprise and the high efficiency in the informal activities, the main sales market of the products in the past three years, and the proportion of the employees with bachelor's degree or above in the enterprise. The statistical results are shown in Table 5-7:

Table 5-7 the basic information of enterprises

The basic information		frequency	percentage
topic	item		
industry	IT	20	7.5
	Environmental protection, new energy	14	5.2
	mechatronics	10	3.7
	telecommunication	15	5.6
	biomedicine	11	4.1
	manufacturing industry	117	43.7
	chemical industry	14	5.2
	agriculture	17	6.3
	others	50	18.7
The current legal status	Publicly traded or listed company	14	5.2
	Non publicly traded shareholding companies	14	5.2
	Private, non-listed company	202	75.4
	Subsidiary/division of a domestic enterprise	8	3
	Subsidiary/division of a multinational firm	1	0.4
	Joint venture of a domestic enterprise (domestic investment scheme)	5	1.9
	Joint venture of a multinational firm (foreign investment scheme)	3	1.1
	State owned company	4	1.5
	others	17	6.3
Frequency of interaction with universities in informal activities	no relationship	90	33.6
	very infrequently, once a year or less	84	31.3
	once every 6 months or less	39	14.6
	being every 2 months	40	14.9
	being every being every two weeks	9	3.4
	very frequently, nearly every day	6	2.2
Major produce maskets（Last 3 years）	Local / regional within your province	133	49.6
	National (other regions of [your country])	104	38.8
	Asian countries	7	2.6
	All other countries	24	9
Percentage of undergraduate and above	0%	27	10.1
	1% to less than 5%	93	34.7
	5% to less than 10%	41	15.3
	10% to less than 25%	41	15.3
	25% to less than 50%	31	11.6
	50% to less than 75%	12	4.5
	75% or more	23	8.6

From the results of the above table, we can see the proportion of the basic information of enterprises. From the point of the industry in which the enterprise is located, the

manufacturing enterprises are the majority, accounting for 43.7%, the distribution of IT, electronics, chemical industry and other industries is uniform. In general, the object of investigation takes into account all kinds of industries. From the legal status of enterprises, more than 75% of the enterprises surveyed are private non-listed companies. For the investigation of the frequency of interaction between enterprises and colleges and universities in informal activities, only nearly 20% of enterprises interact frequently, which may interact with colleges and universities every two months, and the interaction between enterprises and colleges and universities is relatively small on the whole. This may be because the interaction between enterprises and colleges and universities occurs more in formal activities. This data also tells us that enterprise managers also need to pay attention to the interaction with colleges and universities in informal activities to deepen the relationship with colleges and universities. Among the enterprises interviewed, most of the product market is still aimed at domestic, the more general business sales in the province. As for the problem of the proportion of employees' academic qualifications, it can be seen from the table that only 13.1% of the surveyed enterprises have more than 50% of the total employees, which shows that enterprises still need to continue to attract talents.

5.2.2 the basic personal information

The basic personal information is shown in Table 5-8. From the point of age, nearly 80% of the participants are distributed between 30-50 years old, this part of the group in the enterprise is the middle and senior manager, which have more understanding to the various situations of the enterprise. By gender, 57.5% were men and 42.5% were women. From the distribution of academic qualifications, nearly 85% of the respondents in college and above. Nearly 80% of the respondents were in positions of middle management or above of the company, which is consistent with the age distribution. The middle and senior managers have a deeper understanding of the enterprise and a more thorough understanding of the related problems of the enterprise, which is the key object of this study. In addition, we cannot ignore the employees' understanding of the enterprise. Based on the analysis above, the data are representative and reliable.

Table 5-8 the basic information of respondents

the basic information of respondents		Frequency	Percentage (%)
	item		

age	Under 20 years	6	2.2
	20-29 years	23	8.6
	30-39 years	111	41.4
	40-49 years	93	34.7
	50-60 years	27	10.1
	60 plus years	8	3.0
gender	male	154	57.5
	female	114	42.5
Level of Education	High school	42	15.7
	Diploma	109	40.7
	Undergraduate technical degree	60	22.4
	Undergraduate non-technical degree	33	12.3
	Postgraduate technical degree	12	4.5
	Postgraduate non-technical degree	7	2.6
	others	5	1.9
current position in the firm	CEO	20	7.5
	Founder	42	15.7
	Senior manager/director	55	20.5
	Middle manager	97	36.2
	foreperson/Supervisor	4	1.5
	worker/employee	50	18.7

5.3 Hypothesis Testing

5.3.1 Test of Direct Effect

(1) the impact of external knowledge on corporate performance

The chapter 3 assumes that the higher the level of knowledge acquisition and the higher the degree of knowledge sharing, the higher the performance of enterprises. Therefore, based on this assumption, the structural equation model of the influence of external knowledge on enterprise performance is constructed, as shown in Figure 5-6.

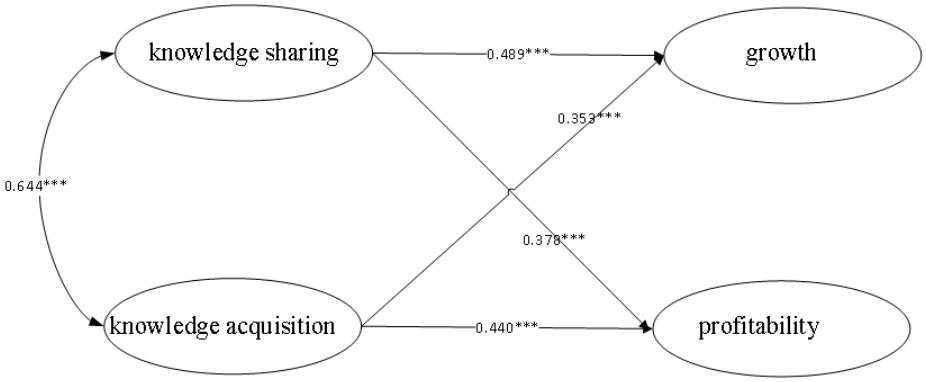

Figure 5-6 The influence of External Knowledge on Corporate Performance

The sample data was substituted into AMOS 24.0 to obtain the fitting degree index of the direct effect of external knowledge on enterprise performance, as shown in Table 5-9. Among them, the chi-square degree of freedom ratio is 2.298, RMSEA value is 0.070, less than 0.08, and GFI is 0.805, indicating that this model has the good fit degree.

Table 5-9 the testing of fit degree of relationship models that external knowledge on enterprise performance

χ^2 / df	RMSEA	GFI
2.298	0.070	0.805

As shown in Table 5-10, knowledge sharing has a significant positive effect on enterprise growth from the influence coefficient and action relationship in the table, and the path coefficient is 0.489. Thus, the hypothesis of knowledge sharing and growth in the H1 is verified. Similarly, knowledge sharing has a significant positive effect on enterprise profitability, the path coefficient is 0.378. Knowledge acquisition significantly positively affects enterprise growth performance, which path coefficient is 0.353 and knowledge acquisition has a significant positive effect on profitability, with 0.44 of path coefficient. Overall, the hypothesis of H1 that external knowledge is positively correlated to enterprise performance is validated.

Table 5-10 the testing results of the relationship between external knowledge and enterprise performance

	Standardized Path Coefficient	S.E.	C.R.	P	Hypothesis
growth<--- knowledge sharing	0.489	0.108	4.735	***	hold
profitability<---knowledge sharing	0.378	0.078	4.796	***	hold
growth<--- knowledge acquisition	0.353	0.064	5.262	***	hold
profitability<--- knowledge acquisition	0.44	0.065	6.137	***	hold

（2）the impact of external knowledge on collaborative innovation

As for the relationship between external knowledge and collaborative innovation, it is assumed that the knowledge acquisition ability and knowledge sharing level of enterprises will positively affect the collaborative innovation of enterprises. Based on the H2 of hypothesis, the structural equation model of the relationship between external knowledge and collaborative innovation is constructed. As shown in Figure 5-7.

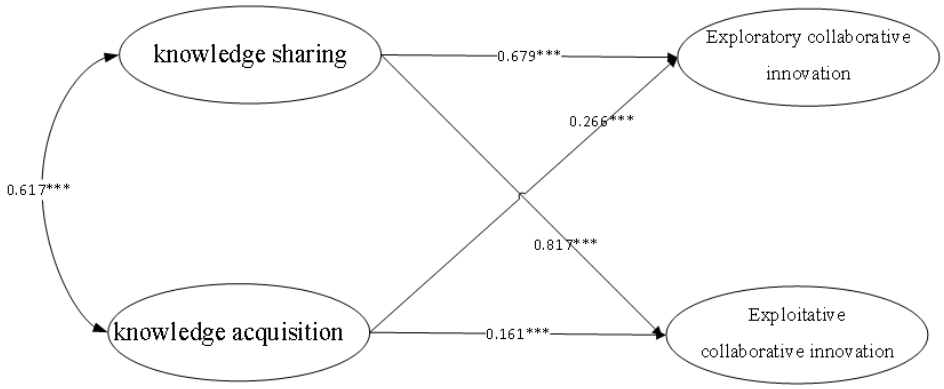

Figure 5-7 The influence of external Knowledge on collaborative innovation

By importing the sample data into AMOS 24.0, the fitting index of the direct effect of external knowledge on collaborative innovation is shown in Table 5-11. where chi-square degree of freedom ratio is 2.806, the RMSEA value is 0.082, through the value of RMSEA is slightly higher than 0.08, it is still in the acceptable range, and the GFI is 0.762, so the model has good adaptability.

Table 5-11 the testing of fit degree of relationship of model that external knowledge on collaborative innovation

χ^2 / df	RMSEA	GFI
2.806	0.082	0.762

As shown in Table 5-12, knowledge sharing has a significant positive effect on exploratory collaborative innovation, and the path coefficient is 0.679. Therefore, it is verified that the hypothesis of knowledge sharing and exploratory collaborative innovation in H2. Similarly, knowledge sharing has a significant positive innovation on exploratory collaborative innovation, and the path coefficient is 0.817. In contrast, it is higher than on exploratory collaborative innovation. Knowledge acquisition has a significant positive impact on exploratory collaborative innovation, with a path coefficient of 0.266. and also has a significant positive impact on exploitative collaborative innovation, with a significant coefficient of 0.161. Compared with knowledge sharing, knowledge acquisition has a lower impact on collaborative innovation, indicating that enterprises need not only acquire knowledge from outside, but also share and internalize it into their own knowledge. overall, the hypothesis of H2 that external knowledge is positively correlated with collaborative innovation is validated.

Table 5-12 the testing results of the relationship between external knowledge and collaborative innovation

	Standardized Path Coefficient	S.E.	C.R.	P	Hypothesis
exploratory collaborative innovation <---knowledge sharing	0.679	0.077	7.949	***	hold
exploitative collaborative innovation <---knowledge sharing	0.817	0.059	13.495	***	hold
exploratory collaborative innovation <---knowledge acquisition	0.266	0.053	4.352	***	hold
exploitative collaborative innovation <---knowledge acquisition	0.161	0.046	3.311	***	hold

（3）the impact of collaborative innovation on enterprise performance

The collaborative innovation of enterprises will affect the innovation performance of enterprises. Collaborative innovation is divided into two dimensions: exploratory collaborative innovation and exploitative collaborative innovation. Based on the previous assumptions, the structural equation model of collaborative innovation for enterprise innovation performance is constructed. As shown in Figure 5-8.

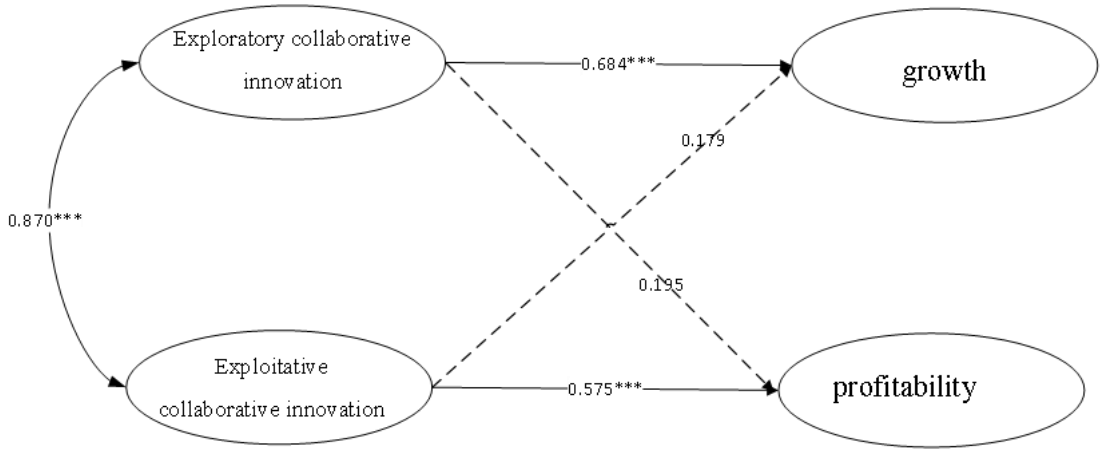

Figure 5-8 The influence of collaborative innovation on enterprise performance

By importing the sample data into AMOS 24.0, the fitting index of the direct effect of collaborative innovation on enterprise performance is shown in Table 5-13. where chi-square degree of freedom ratio is 2.473, the RMSEA value is 0.074, which is less than 0.08, and the GFI is 0.772, so the model has good adaptability.

Table 5-13 the testing of fit degree of relationship of model that collaborative innovation on enterprise performance

χ^2 / df	RMSEA	GFI
2.473	0.074	0.772

The testing results are shown in Table 5-14. According to the influence coefficient and relationship in the table, exploratory collaborative innovation has a significant positive effect on enterprise growth, and the path coefficient is 0.684. Therefore, the hypothesis of collaborative innovation has a significant positive effect on enterprise growth in H3 is validated. Also, the exploitative collaborative innovation has a significant positive impact on the profitability of the enterprise, the path coefficient is 0.575. However, the other two assumptions are not verified. In general, the positive correlation in hypothesis H3 has been verified partly.

Table 5-14 the testing results of the relationship between collaborative innovation and enterprise performance

	Standardized Path Coefficient	S.E.	C.R.	P	Hypothesis
growth<---exploratory collaborative innovation	0.684	0.145	5.316	***	hold
profitability<---exploratory collaborative innovation	0.195	0.138	1.415	0.157	unverified
growth<---exploitative collaborative innovation	0.179	0.155	1.311	0.19	unverified
profitability<---exploitative collaborative innovation	0.575	0.142	4.111	***	hold

5.3.2 Test of mediating Effect

When choosing the method to test the mediating effect, the scholars mainly adopt the causality stepwise regression test method, but in recent years, many scholars have questioned the B-K method. Afterwards, scholars recommend the Sobel test method to verify the mediating effect, but this method also has great disadvantages. Trust interval method is a more accurate method to test the mediating effect at present. In this thesis, the Boot strapping test method proposed by the Taylor (2008) is used to test the mediating effect of exploratory collaborative innovation and exploitative collaborative innovation

in the path of external knowledge effecting the performance of the enterprise. The confidence interval level is 95%.

(1) the mediating effect test of exploratory collaborative Innovation

The influence mechanism of external knowledge to enterprise performance is studied and the mediation effect tested of exploratory collaborative Innovation is tested by applying AMOS 24.0 to construct the structural equations model. As shown in Figure 5-9. Firstly, we need to look at the fit of the model, the value of RMSEA is 0.099, the fitness is not ideal. Based on the revised indicators MI provided by the AMOS, the model was modified twice, we established the relationships between e27 and e28, e17 and e19. After operation, the chi-square degree of freedom ratio is 3.254, which is less than 4, to an acceptable extent. The RMSEA is 0.929, Less than 0.10, and CFI is 0.935, IFI is 0.935 and TLI is 0.929, they are greater than 0.9, which shows that the modified model is well adapted and can be used to verify the corresponding assumptions.

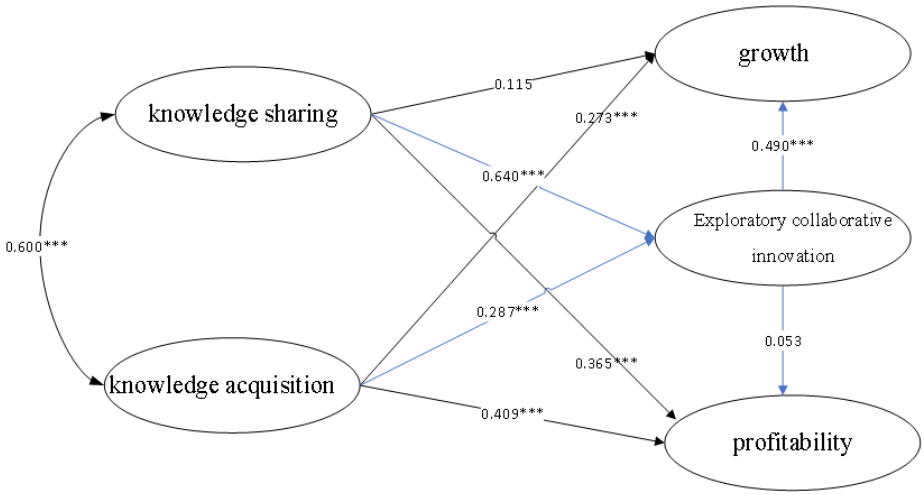

Figure 5-9 The intermediation of exploratory collaborative innovation

The Bootstrap method and the mediating effect test program proposed by Wen (2017) are used to test the mediating effect of exploratory collaborative innovation. The test results are shown in Table 5-15.

In the loop of knowledge sharing as independent variable, profitability as dependent variable and exploratory collaborative innovation as mediating variable, we can find that the Z value of the indirect effect point of knowledge sharing on profitability is 0.431, less than 1.96. At the same time, the confidence intervals of indirect effects for Bias-Corrected Method and Percentile Method at 95% confidence levels contains zero, which shows that the mediating effect of "knowledge sharing →exploratory collaborative innovation →

profitability" is not significant. The path of "Knowledge acquisition → exploratory collaborative innovation → profitability' is analogous, that is to say, the exploratory collaborative innovation has no significant mediating effect on this path.

The Z value of indirect effect point estimation of knowledge sharing for growth is 3.230, which is greater than 1.96. and the confidence interval of indirect effect for Bias-Corrected Method and Percentile Method does not contain zero at 95% confidence levels, which indicates that the mediating effect of exploratory collaborative innovation in the path of "knowledge sharing → exploratory collaborative innovation → growth" is significant. At the same time, knowledge sharing has no significant direct effect on growth, so the exploratory collaborative innovation has a complete mediating effect on the interaction between knowledge sharing and growth.

The Z value of indirect effect point estimation for growth is 3.0, which is greater than 1.96, and the confidence interval of indirect effect for Bias-Corrected Method and Percentile Method does not contain zero at 95% confidence, which indicates that the mediating effect of exploratory collaborative innovation in the path of "knowledge acquisition→exploratory collaborative innovation→growth" is significant. At the same time, knowledge acquisition also has a significant direct effect on growth, so the exploratory collaborative innovation has a partial mediating effect on the interaction between knowledge acquisition and growth.

Table 5-15 the mediating effect test of exploratory collaborative Innovation

Variables	The value of point estimation	Coefficient Phase product		Bootstrapping				
				Bias-Corrected 95% CI		Percentile 95% CI		The explanation of results
		SE	Z	Lower	Upper	Lower	Upper	
Knowledge sharing→profitability								
Indirect Effects	0.044	0.102	0.431	-0.118	0.277	-0.113	0.285	inexistence
Direct Effects	0.398	0.124	3.210	0.157	0.628	0.117	0.604	
Knowledge sharing→growth								
Indirect Effects	0.365	0.113	3.230	0.203	0.648	0.197	0.634	The mediating effect exists
Direct Effects	0.13	0.115	1.130	-0.086	0.382	-0.107	0.343	Complete mediating effect
Knowledge acquisition→profitability								
Indirect Effects	0.017	0.035	0.486	-0.056	0.083	-0.054	0.084	inexistence

Direct Effects	0.386	0.059	6.542	0.273	0.511	0.273	0.51	
Knowledge acquisition→growth								
Indirect Effects	0.144	0.048	3.000	0.244	0.244	0.054	0.243	The mediating effect exists
Direct Effects	0.265	0.066	4.015	0.151	0.414	0.138	0.399	Partial mediating effect

(2) the mediating effect test of exploitative collaborative Innovation

Applying AMOS 24.0 to study the influence mechanism of external knowledge effecting enterprise performance and examining the role of exploitative collaborative innovation in the relationship between external knowledge and enterprise innovation performance. Building the structural equations as shown in Figure 5-10. First look at the fit of the model, the RMSEA is 0.101 and the chi-square degree of freedom ratio is 3.730, the fitness is not ideal. Based on the revised indicators provided by the AMOS, the model has been modified three times. We added the correlation relationship in e27 and e28, e7 and e8, e23 and e26. After operation, the fitting index is 3.248 degrees of freedom ratio of chi-square, less than 4, the RMSEA is 0.092, CFI is 0.936, IFI is 0.937, TLI is 0.930, all the indicators are within the acceptable range, which shows that the modified model is well adapted and can be used to verify the corresponding assumptions.

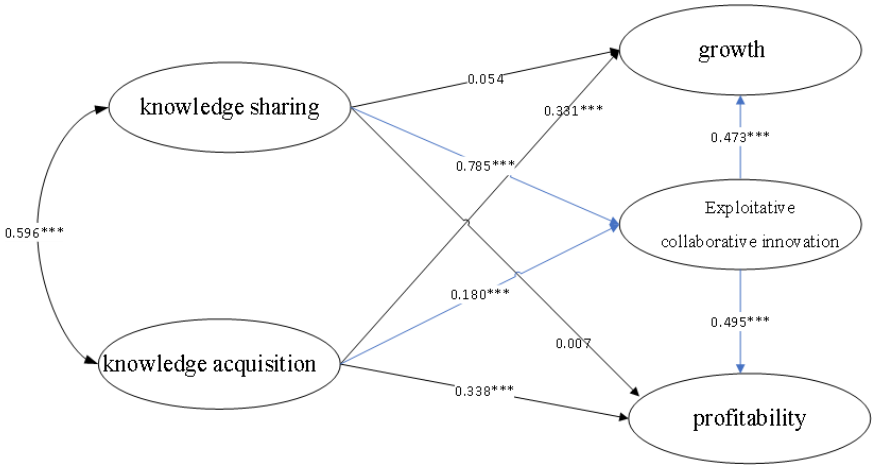

Figure 5-10 The intermediation of exploitative collaborative innovation

Using the same method to test the mediating effect of exploitative collaborative innovation. The test results are shown in Table 5-16. In the loop of knowledge sharing as independent variable, profitability as dependent variable, exploitative collaborative innovation as mediating variable, we can find that the Z value of the indirect effect point of knowledge sharing on profitability is 4.659, which is more than 1.96, and the

confidence intervals of indirect effects for Bias-Corrected Method and Percentile Method at 95% confidence do not contain zero, which shows that the mediating effect of exploitative collaborative innovation in the path of "knowledge sharing→exploitative collaborative innovation→profitability" is significant. Meanwhile, since knowledge sharing has no significant direct effect on profitability, therefore, the exploitative collaborative innovation has a complete mediating effect on the interaction between knowledge sharing and profitability. Similar to "knowledge sharing→exploitative innovation performance→growth", exploitative collaborative innovation has a complete mediating effect on this path.

The Z value of indirect effect point estimation for profitability is 3.0, which is greater than 1.96, and the confidence interval of indirect effect for Bias-Corrected Method and Percentile Method at 95% confidence does not contain zero, which indicates that the mediating effect of exploitative collaborative innovation in the path of "knowledge acquisition→exploitative collaborative innovation→profitability" is significant. In the same way, exploitative collaborative innovation has partly mediating effect between knowledge acquisition and growth.

Table 5-16 the mediating effect test of exploitative collaborative Innovation

Variables	The value of point estimation	Coefficient Phase product		Bootstrapping				The explanation of results
				Bias-Corrected 95% CI		Percentile 95% CI		
		SE	Z	Lower	Upper	Lower	Upper	
Knowledge sharing→profitability								
Indirect Effects	0.433	0.093	4.656	0.277	0.659	0.272	0.640	The mediating effect exists
Direct Effects	0.008	0.101	0.079	-0.195	0.199	-0.199	0.194	Complete mediating effect
Knowledge sharing→growth								
Indirect Effects	0.431	0.094	4.585	0.227	0.597	0.245	0.622	The mediating effect exists
Direct Effects	0.063	0.126	0.500	-0.169	0.331	-0.177	0.311	Complete mediating effect
Knowledge acquisition→profitability								
Indirect Effects	0.084	0.028	3.000	0.037	0.150	0.033	0.142	The mediating effect exists
Direct Effects	0.319	0.052	6.135	0.215	0.417	0.226	0.423	Partial mediating effect
Knowledge acquisition→growth								

Indirect Effects	0.083	0.032	2.594	0.031	0.159	0.028	0.154	The mediating effect exists
Direct Effects	0.325	0.072	4.514	0.187	0.469	0.182	0.464	Partial mediating effect

5.3.3 Test of Mediation Effect

It is mentioned in the theoretical model that absorptive capacity regulates the relationship between external knowledge and collaborative innovation, and entrepreneurship orientation regulates the relationship between collaborative innovation and corporate performance. When testing the regulation effect, it is usually necessary to centralize the independent variable and the adjusting variable. The central treatment method used here is the method of subtracting the average value. First, adding the independent variable, and calculate the regression coefficient between the independent variable and the dependent variable, then adding the adjusting variable and the interaction term between the adjusting variable and the independent variable, calculate the regression coefficient between the independent variable and the dependent variable, finally compare them.

(1) the regulation role of absorptive capacity

Firstly, test the moderating effect of acquisition ability between external knowledge and collaborative innovation. the Model 1 adds the external knowledge of independent variables, model 2 adds the ability to obtain of moderating variables, and model 3 adds the interaction between independent variables and moderating variables. The regression results are shown in Table 5-17. The effect coefficient of the product of external knowledge and acquisition ability on collaborative innovation is -0.154(P <0.001), and the F value of the model is 347.699, P <0.001, which is significant. That is, the regulation role of acquisition ability for external knowledge and collaborative innovation regulation is significant, the hypothesis of H5a holds.

Table 5-17 the moderating effect of acquisition capacity

Model		Standard coefficient	T	Significance	R^2	$\triangle R^2$	F
1	(Constants)		140.544	0.000	0.740		758.3044***
	External knowledge	0.860	27.537	0.000			
2	(Constants)		151.248	0.000	0.777	0.036	460.64***
	External knowledge	0.644	14.640	0.000			

	acquisition capacity	0.289	6.562	0.000			
3	(Constants)		144.572	0.000	0.798	0.021	347.699***
	External knowledge	0.625	14.854	0.000			
	acquisition capacity	0.258	6.108	0.000			
	External knowledge* acquisition capacity	-0.154	-5.290	0.000			

Dependent variables: collaborative innovation

Second, testing the moderating effect of assimilate ability. The regression results are shown in Table 5-18. The regression coefficient of external knowledge to collaborative innovation is 0.860 (P<0.001). After adding adjusting variable of assimilate ability, the regression coefficient becomes 0.698 (P<0.001). The effect coefficient of interaction between knowledge acquisition and assimilate ability on exploratory collaborative innovation is -0.358 (P<0.05). The moderating effect of assimilate ability in the relation of external knowledge and collaborative innovation is significant, and the hypothesis of H5b holds.

Table 5-18 the moderating effect of assimilation ability

Model		Standard coefficient	T	significance	R^2	$\triangle R^2$	F
1	(Constants)		140.544	0.000	0.740		758.304***
	External knowledge	0.860	27.537	0.000			
2	(Constants)		150.622	0.000	0.775	0.034	455.738***
	External knowledge	0.698	18.019	0.000			
	Assimilate ability	0.247	6.365	0.000			
3	(Constants)		145.275	0.000	0.792	0.017	334.939***
	External knowledge	1.057	12.362	0.000			
	Assimilate ability	0.205	5.344	0.000			
	External knowledge *Assimilate ability	-0.358	-4.669	0.000			

Dependent variables: collaborative innovation

Third, we verify the moderating effect of transformation ability. The regression results are shown in Table 5-19. The regression coefficient of external knowledge to collaborative innovation is 0.860 (P<0.001). After adding adjusting variable of transformation ability, the regression coefficient becomes 0.626 (P<0.001) and the influence coefficient of the product of external knowledge and transformation ability of interaction term is -0.154(P <0.05). That is, transformation ability has a significant moderating effect between external knowledge and collaborative innovation.

Table 5-19 the moderating effect of transformation ability

Model		Standard coefficient	t	significance	R^2	$\triangle R^2$	F
1	(Constants)		140.544	0.000	0.740		758.304***
	External knowledge	0.860	27.537	0.000			
2	(Constants)		156.794	0.000	0.792	0.052	504.936***
	External knowledge	0.626	15.563	0.000			
	Transformation ability	0.327	8.128	0.000			
3	(Constants)		152.167	0.000	0.813	0.021	382.896***
	External knowledge	0.616	16.095	0.000			
	Transformation ability	0.282	7.208	0.000			
	External knowledge* Transformation ability	-0.154	-5.445	0.000			

Dependent variables: collaborative innovation

Fourth, we verify the moderating effect of the application ability, the results are shown in Table 5-20 below. The influence coefficient of the product of external knowledge and application ability on exploratory collaborative innovation is -0.167(P<0.05), that is, the adjustment effect of application ability between external knowledge and collaborative innovation is significant.

Table 5-20 the moderating effect of application ability

model		Standard coefficient	t	significance	R2	△R2	F

1	(Constants)		140.544	0.000	0.740		758.304***
	External knowledge	0.860	27.537	0.000			
2	(Constants)		150.898	0.000	0.776	0.035	457.901***
	External knowledge	0.687	17.336	0.000			
	application ability	0.256	6.453	0.000			
3	(Constants)		148.388	0.000	0.801	0.025	353.956***
	External knowledge	0.669	17.827	0.000			
	application ability	0.220	5.817	0.000			
	External knowledge* application ability	-0.167	-5.793	0.000			
Dependent variables: collaborative innovation							

（2）the moderating effect of entrepreneurship orientation

The first is the test of the moderating effect of innovation between collaborative innovation and enterprise performance, as shown in Table 5-21. Model 1 shows that the influence coefficient of collaborative innovation on enterprise performance is 0.798 (P <0.001). As can be seen in model 3, the regression coefficient becomes 0.481 (P<0.001) after adding the adjustment variable of innovation, that is, the adjustment term. The regression coefficient of the product of interaction item between innovation and exploitative collaborative innovation is 0.128 (P<0.01), and the F value in model 3 is 185.519, P<0.001, which is significant, that is, innovation plays a significant role in regulating collaborative innovation and enterprise performance.

Table 5-21 the moderating effect of innovation

Model		Standard coefficient	t	significance	R^2	$\triangle R^2$	F
1	(Constants)		100.736	0.000	0.636		465.080***
	collaborative innovation	0.798	21.566	0.000			
2	(Constants)		105.114	0.000	0.667	0.031	265.499***
	collaborative innovation	0.429	5.205	0.000			
	innovation	0.409	4.962	0.000			

3	(Constants)		90.847	0.000	0.678	0.011	185.519***
	collaborative innovation	0.481	5.799	0.000			
	innovation	0.430	5.280	0.000			
	collaborative innovation*innovation	0.128	3.029	0.003			

Dependent variables: corporate performance

Second, the test of the moderating effect of risk-taking between collaborative innovation and performance is shown in Table 5-22. The influence coefficient of interaction item that collaborative innovation and risk-taking on enterprise performance is 0.113 (P <0.01), and the F value is 206.517, P <0.001, which is significant, that is, risk-taking plays a significant moderating effect between collaborative innovation and enterprise performance.

Table 5-22 the moderating effect of risk-taking

model		Standard coefficient	T	significance	R^2	$\triangle R^2$	F
1	(Constants)		100.736	0.000	0.635		465.080***
	collaborative innovation	0.798	21.566	0.000			
2	(Constants)		109.316	0.000	0.690	0.056	297.959***
	collaborative innovation	0.514	9.646	0.000			
	Risk-taking	0.370	6.946	0.000			
3	(Constants)		96.337	0.000	0.698	0.009	206.517***
	collaborative innovation	0.585	10.032	0.000			
	Risk-taking	0.356	6.742	0.000			
	collaborative innovation* Risk-taking	0.113	2.823	0.005			

Dependent variables: corporate performance

Third, the test of the moderating effect of proactiveness between collaborative innovation and performance is carried out. The regression results are shown in Table 5-23. The influence coefficient of the product of interaction item that collaborative innovation and proactiveness on enterprise performance is 0.127 (P <0.001), and the F value is 185.265,

P <0.001, which indicates that proactiveness plays a significant moderating effect between collaborative innovation and enterprise performance.

Table 5-23 the moderating effect of proactiveness

model		Standard coefficient	T	significance	R^2	$\triangle R^2$	F
1	(Constants)		100.736	0.000	0.636		465.080***
	collaborative innovation	0.798	21.566	0.000			
2	(Constants)		105.088	0.000	0.667	0.031	265.300***
	collaborative innovation	0.474	6.374	0.000			
	proactiveness	0.368	4.947	0.000			
3	(Constants)		92.082	0.000	0.678	0.011	185.265***
	collaborative innovation	0.532	7.023	0.000			
	proactiveness	0.383	5.209	0.000			
	collaborative innovation* proactiveness	0.127	3.010	0.003			
Dependent variables: corporate performance							

5.4 Summary of Test Results

The hypothesis is tested by the above analysis, and the conclusions are summarized here, the concrete research conclusions are shown in Table 5-24.

Table 5-24 the summary of inspection results

Research subjects	Specific content	Hypothesis testing
H1	External knowledge has a positive impact on corporate performance	hold
H1a	Knowledge acquisition has a positive effect on growth performance	hold
H1b	Knowledge acquisition has a positive effect on enterprise profitability performance	hold
H1c	Knowledge sharing has a positive effect on growth performance	hold
H1d	Knowledge sharing has a positive effect on enterprise profitability performance	Hold
H2	External knowledge has a significant positive impact on collaborative innovation	Hold
H2a	Knowledge acquisition has a significant positive effect on exploratory collaborative innovation	Hold
H2b	Knowledge acquisition has a significant positive effect on exploitative collaborative innovation	Hold
H2c	Knowledge sharing has a significant positive effect on exploratory collaborative innovation	Hold

H2d	Knowledge sharing has a significant positive effect on exploitative collaborative innovation	Hold
H3	Collaborative innovation has a significant positive impact on corporate performance	The part is hold
H3a	Exploratory collaborative innovation has a significant positive effect on growth performance	hold
H3b	Exploratory collaborative innovation has a significant positive effect on the profitability of enterprises	Unverified
H3c	Exploitative collaborative innovation has a significant positive impact on growth performance	Unverified
H3d	Exploitative collaborative innovation has a significant positive impact on the profitability of enterprises	hold
H4	Collaborative innovation plays a mediating role between external knowledge and knowledge transfer performance.	hold
H4a	Exploratory collaborative innovation plays a mediating role between external knowledge and enterprise performance	The part is hold
H4a1	Exploratory Collaborative Innovation plays a mediating role in knowledge acquisition and enterprise growth	Partial mediating effect
H4a2	Exploratory collaborative innovation plays a mediating role in knowledge acquisition and enterprise profitability	Unverified
H4a3	Exploratory Collaborative Innovation plays a mediating role in knowledge sharing and enterprise growth	Complete mediating effect
H4a4	Exploratory collaborative innovation plays a mediating role in knowledge sharing and enterprise profitability	Unverified
H4b	Exploitative collaborative innovation plays a mediating role between external knowledge and enterprise performance	hold
H4b1	Exploitative collaborative innovation plays a mediating role in knowledge acquisition and enterprise growth	Partial mediating effect
H4b2	Exploitative collaborative innovation plays a mediating role in knowledge acquisition and enterprise profitability	Partial mediating effect
H4b3	Exploitative collaborative innovation plays a mediating role in knowledge sharing and enterprise growth	Complete mediating effect
H4b4	Exploitative collaborative innovation plays a mediating role in knowledge sharing and enterprise profitability	Complete mediating effect
H5	Absorption plays a moderating effect between external knowledge and collaborative innovation	hold
H5a	Acquisition ability plays a moderating effect between external knowledge and collaborative innovation	hold
H5b	Assimilate ability plays a moderating effect between external knowledge and collaborative innovation	hold
H5c	Transformation ability plays a moderating effect between external knowledge and collaborative innovation	hold
H5d	Application ability plays a moderating effect between external knowledge and collaborative innovation	hold
H6	Entrepreneurship orientation plays a moderating effect between collaborative innovation and corporate performance	hold

H6a	Innovation plays a moderating effect between collaborative innovation and corporate performance	hold
H6b	Risk-taking plays a moderating effect between collaborative innovation and corporate performance	hold
H6c	proactiveness plays a moderating effect between collaborative innovation and corporate performance	hold

6 CONCLUSION AND DISCUSSION

This chapter discusses the relationship between the variables in the model by analyzing the research assumptions and test results, then makes corresponding suggestions combining the test results with the actual background and according to the characteristics of the University Science and Technology Park.

6.1 Results Discussion

6.1.1 Results of Model

(1) In the influence of external knowledge on the performance of knowledge transfer, knowledge sharing has a significant positive effect on the growth performance and profitability performance of enterprises (β =0.489, P<0.001; β =0.378, P<0.001), which shows that assumptions H1a and H1b are valid. Enterprises can turn individual knowledge into collective knowledge and social knowledge through knowledge sharing. In the process of sharing knowledge, enterprises can integrate their knowledge well and have a deeper understanding of their own knowledge in the process of using knowledge, so as to make full use of their knowledge to improve their performance. From the results, we can see that the impact of knowledge sharing on enterprise growth performance is slightly higher than that on profitability performance. This may because knowledge is the strategic resource of enterprises, so the effective use of knowledge can not only improve the short-term interests of enterprises. In the long run, the higher the level of knowledge sharing is, the higher the degree of mastery of the knowledge absorption is, the more it can promote the growth of the enterprise.

Knowledge acquisition also has significant positive effects on growth performance and profitability performance (β =0.353, P<0.001; β =0.44, P<0.001), the hypothesis of H1c and H1d are tested, which stated that enterprises only rely on their own internal knowledge is far from enough, but also need to acquire knowledge from the outside. Acquiring knowledge from the outside can improve the knowledge stock within the enterprise, and cooperation with different knowledge sources can help the enterprise to bring complementary resources, which can reduce the cost of the enterprise and improve the performance of the enterprise. Compared with knowledge sharing, knowledge

acquisition has a greater impact on enterprise profitability performance, and knowledge sharing has a greater impact on enterprise growth performance. The reason for this result may be that knowledge acquisition only emphasizes the process of acquiring knowledge from outside in this research. Enterprises obtain the necessary resources from various external knowledge sources to help them operate and obtain profits. The purposeful knowledge sharing of enterprises can promote enterprises to integrate knowledge, and ultimately realize knowledge creation, which can bring new knowledge, expand new fields, and realize the sustainable development of enterprises. Therefore, we cannot just stop at acquiring knowledge from the outside, the key lies in how to internalize the outside knowledge into our own knowledge and make use of it.

(2) In the impact of external knowledge on collaborative innovation, knowledge sharing has a significant positive effect on exploratory collaborative innovation and exploitative collaborative innovation, the hypothesis of H2a and H2b are established (β =0.679, P <0.001; β =0.817, P <0.001). The exploratory collaborative innovation depends on new knowledge and new technologies, the exploitative collaborative innovation depends on the effective use of existing knowledge, knowledge sharing can promote both exploratory collaborative innovation and exploitative collaborative innovation. The existing knowledge can be effectively stored and maintained through knowledge sharing among members of the organization to promote the efficient application of existing knowledge by employees, which can improve the ability of cooperative innovation. In addition, in the process of knowledge sharing, the "multiple thinking" among partners is triggered, which encourages business members to explore new knowledge and opportunities of innovation, thereby promote enterprises to carry out the activities of exploratory collaborative innovation.

Knowledge acquisition also has a significant positive impact on exploratory collaborative innovation and exploitative collaborative innovation. The hypothesis of H2c and H2d are established (β =0.266, P <0.001; β =0.161, P <0.001). From the data analysis results, we can see that knowledge acquisition has less impact on collaborative innovation than knowledge sharing. The importance of knowledge sharing for enterprises is verified again. After acquiring external knowledge, enterprises also need to digest, integrate and actively share knowledge. Enterprises need to have enough knowledge for collaborative innovation. The larger the knowledge stock, the stronger the cooperative innovation

ability of enterprises. The exploratory collaborative innovation activities require enterprises to have advanced and novel knowledge to help enterprises adapt to the rapidly changing environment. Knowledge acquisition can improve the knowledge breadth and depth of enterprises and help enterprises to discover emerging market opportunities. Although the use of collaborative innovation depends more on the existing knowledge base, we can improve the information processing ability of enterprises and help enterprises better understand their own knowledge by acquiring diversified knowledge from the outside, which is conductive to promoting the use of collaborative innovation enterprises.

(3) In the impact of collaborative innovation on enterprise performance, exploratory collaborative innovation has a significant positive impact on enterprise growth performance (β =0.684, P<0.001), the H3a is tested. While the positive impact on firm profitability is not significant and the hypothetical of H3b is invalid (β =0.195, P=0.157). The possible reason is that exploratory collaborative innovation emphasizes that enterprises explore new knowledge, develop new technology and open up new business, with the characteristics of high risk and long cycle, so under the uncertain environment, the effect on the current profit performance of enterprises is not so obvious. However, exploratory collaborative innovation can help enterprises break through the existing knowledge base and make enterprises focus on meeting the new needs of emerging markets and customers. Under the exploratory collaborative innovation activities, enterprises can quickly find the sensitive points and potential needs of the market, which is conducive to the enterprises to produce new products and open new markets. Through it, the opportunities for the development of enterprises will be provided and the growth performance of enterprises will be improved.

The result of exploitative collaborative innovation is the opposite, and its influence on corporate profitability is more significant (β =0.575, P <0.001), the hypothesis of H3c is hold, but the positive effect on enterprise growth is not significant, the hypothesis of H3d does not hold (β =0.179, P=0.155). This may be because the exploitative collaborative innovation emphasizes that enterprises meet the existing needs of customers based on current knowledge, using the knowledge of competitors, consumers, markets to improve existing products and services. Compared with exploratory collaborative innovation, the risk of exploitative collaborative innovation activities is small and the cycle is short,

which tends to tap the needs of customers and make gradual changes to the products. The goal is to use better products to surpass competitors and obtain short-term expected benefits. However, due to too much attention to the use of current knowledge instead of research and development, it has little contribution to the growth performance of enterprises.

(4) The exploratory and exploitative collaborative innovation play a different role in mediating external knowledge and enterprise performance. For exploratory collaborative innovation, its mediating effect in the path of knowledge sharing and profitability and the path of knowledge acquisition and profitability is not obvious, which shows that the relationship between external knowledge and corporate profitability does not need to be realized through exploratory innovation activities. This may be due to the lack of relationship between exploratory collaborative innovation and corporate profitability. Exploratory collaborative innovation plays a complete mediating role in the path of knowledge sharing and growth, that is to say, the influence of knowledge sharing on enterprise growth is mainly realized through the exploratory collaborative innovation activities of enterprises. Knowledge is the most important resource for enterprises to carry out collaborative innovation. Enterprise collaborative innovation needs to allocate and integrate knowledge, knowledge sharing is one of the key steps. On the basis of knowledge sharing, enterprises accumulate new knowledge, develop new knowledge, apply new knowledge, quickly gain first-mover advantage, surpass competitors and improve enterprise performance. Exploratory collaborative innovation plays a mediating role in the path of knowledge acquisition and growth.

The mediating effect of exploitative collaborative innovation exists between external knowledge and enterprise performance. It plays a complete mediating role between knowledge sharing and enterprise performance, while it plays a partial mediating role between knowledge acquisition and enterprise performance. After acquiring knowledge from the outside and sharing knowledge, the enterprise improves the knowledge stock and provides the knowledge base for the exploitative collaborative innovation activities. Through the exploitative collaborative innovation, the enterprise uses these knowledge and skills to improve the existing products and services and improve the performance of the enterprise. Combined with the above results, it can be seen that knowledge sharing itself is not easy to improve enterprise performance, which plays a great role in enterprise

performance through the cooperative innovation activities of enterprises to a large extent. Only acquiring knowledge cannot directly increase enterprise performance, it is necessary to transform the acquired knowledge into commercial products and services through the collaborate innovation activities, and then bring performance to enterprises. After the knowledge transfer, if the enterprise does not carry on the collaborate innovation, the knowledge achievement is difficult to transform into the commercial benefit, which cannot bring the enterprise performance.

(5) The dimensions of absorptive capacity play a significant moderating effect between external knowledge and collaborative innovation. Absorptive ability is a kind of dynamic ability, which can be divided into the ability to acquire, digest, transform and apply knowledge according to the process of absorbing knowledge. Acquisition ability refers to the ability to collect, identify and acquire external knowledge, which is the initial stage of absorptive ability. The ability of acquiring knowledge determines the difficulty of obtaining external knowledge and the quality level of acquired knowledge. Digestion ability refers to the process that enterprises internalize external knowledge into their own knowledge by analyzing external knowledge and understanding external knowledge. Only by digesting external knowledge well can enterprises make effective use of it. Transformation ability refers to the effective integration of external acquired knowledge with the original knowledge of the enterprise, and the integration of new and old knowledge can create more opportunities. The ability of applying knowledge refers to the ability to apply knowledge to the operation of enterprises to produce commercial results. Only by having the ability to transform knowledge into results can knowledge bring performance to enterprises. In general, the higher the absorptive capacity of enterprises, the more obvious the impact of external knowledge on enterprise performance. Absorptive ability can enhance the internalization and utilization of external knowledge. The ability of acquisition and digestion are the basis of knowledge transfer. The ability of transformation and application is the key to transform external knowledge into enterprise performance and improve knowledge transfer efficiency.

(6) The three dimensions of entrepreneurship-oriented play a significant moderating effect between collaborative innovation and corporate performance. Innovation refers to the tendency to pursue new knowledge and new ideas for enterprises and is the degree to which enterprises are willing to innovate. The stronger the innovation of enterprises,

the stronger the willingness to carry out collaborative innovation activities. Risk-taking refers to the degree of enterprise's preference for risk and the tendency to invest resources in projects with greater risk. The risk of exploratory collaborative innovation activities is big and the cycle is strong, so the enterprise with low risk-taking may invest a small amount of resources in exploratory collaborative innovation activities, which will affect their performance. Proactiveness refers to the behavior of enterprises adopting new products before competitors and taking expected actions on products. The stronger the proactiveness, the more likely the enterprise is to seize the market opportunities prior to the competitors and improve the performance of the enterprise. In general, the higher the entrepreneurial orientation, the more enterprises should strengthen their own collaborative innovation activities.

6.1.2 Discussion of Application

The transformation of scientific and technological achievements in university science and technology parks is closely related to universities, enterprises and governments. The efficiency of knowledge transfer is the embodiment of the collaborative results of the above three parties. The triple helix theory shows that the efficient cooperation among government, universities and industry is the key to the success of collaborative innovation. Therefore, in order to achieve sustainable and healthy development, university science and technology parks need to pay attention to the formation of innovation cooperation network, which can be applied in the following aspects.

Firms in university science and technology parks can strengthen collaboration and cooperation with universities, research institutes, professional institutions, etc., and establish a resource link cooperation mechanism. It is also possible to carry out international exchanges and cooperation, and actively attract foreign multinational companies, R&D institutions and research universities to establish high-level R&D institutions in university science parks, and strengthen open collaborative innovation. According to the triple helix theory, the government, enterprises, and universities need to collaborate. As the government-industry-university cooperation continues to deepen, the industry-university-research triple helix has become a new collaborative innovation model that promotes the efficiency of collaborative innovation.

Firms in university science and technology park can rely on the university science and technology park alliance to open up the talent circulation channel between the university

and the university science and technology park, which encourage universities to select qualified scientific researchers to post or cooperate with enterprises in the university science and technology park to carry out scientific and technological innovation projects, encourage universities to set up mobile positions and to explore the establishment of a double-employment mechanism for scientific researchers to work with universities and enterprises, and support scientific researchers from universities to work part-time in enterprises to engage in the transformation of scientific and technological achievements or start companies on the job. Universities are encouraged to guide experts and professors to cooperate with enterprises in the region in production, learning and research to provide solutions for the innovation needs of enterprises.

The university science and technology parks can establish practice communities, encourage enterprises to carry out informal communication, and strengthen the prominent role of informal groups in knowledge transfer and sharing. For example, enterprises can carry out irregular communication and exchange meetings and expert lectures, actively attract teachers, students and alumni resources, and guide the transfer and transformation of scientific and technological achievements in the university science and technology park. We can also maintain the alumni network through the channels such as the celebration and Alumni Association, and conduct informal exchanges with university laboratory teachers to improve the absorptive capacity, guide and promote alumni to start businesses in the university science and technology parks, so as to realize the sustainable development of university science and technology parks.

6.2 Relevant Recommendations

Based on the empirical analysis in this thesis, the following suggestions are made for the development of university science and technology parks.

First, the enterprises of university science and technology park need to improve their initiative and consciousness of acquiring knowledge from outside and sharing knowledge. With the progress of technology, the competition between enterprises is becoming more and more fierce, and it is easy for enterprises to encounter the problem of internal resource constraints. Internal knowledge is often not enough to support enterprises to carry out enough innovation. Acquiring relevant and diversified knowledge from the outside can increase the knowledge stock of enterprises and promote enterprises to innovate. By obtaining resources from external organizations, enterprises can promote the construction

of enterprise innovation resource system and the interaction with partners in innovation network, which is helpful to promote the efficiency of knowledge transfer. Knowledge sharing is an important link of knowledge management. Through knowledge sharing, enterprise members can fully understand and apply their own knowledge, enhance their innovation ability, and improve their performance. The University Science and Technology Park needs to use its own advantages, and actively cooperate with universities, governments and related enterprises to achieve sustainable development.

Second, collaborative innovation is an important condition for enterprises to transform external knowledge into enterprise performance. After acquiring knowledge, enterprises need to actively carry out exploratory collaborative innovation and exploitative collaborative innovation activities in order to internalize external knowledge into their own knowledge and make effective use of knowledge. The managers of enterprises should not only pay attention to the exploitative collaborative innovation activities but also pay attention to the exploratory collaborative innovation activities. At the same time, they should balance the relationship between the two and form a suitable proportion for their own organizational development. Managers need to pay attention to the complementary synergies between the two collaborative innovation activities. In the process of exploitative collaborative innovation activities, enterprises can further transform the results of exploratory collaborative innovation into ways of exploitative innovative activities. In this process, new ideas may be generated to promote new exploratory collaborative innovation activities. Through the cycle, the two cooperative innovation behaviors promote each other to improve the performance of enterprises.

Third, enterprises need to pay attention to the cultivation of absorptive capacity. Enterprises should strengthen their ability to acquire, digest, transform and apply knowledge according to their actual situation. They should draw knowledge and resources from outside and narrow their knowledge gap. The enterprise with strong absorptive capacity can better acquire external knowledge and help enterprises carry out collaborative innovation activities. While strengthening internal learning, enterprises should pay attention to the extension of organizational learning to the outside, and consciously exercise and improve their absorptive capacity in the process of acquiring knowledge, which is very important for enterprises to continuously improve their performance and promote the corporate growth. Enterprises should pay attention to the

cultivation of learning organizational cultural atmosphere, continuously accumulate knowledge through collective learning, improve the knowledge absorption ability of enterprises, take effective learning methods for the acquired knowledge, improve the enterprise information communication technology, and continuously improve the internal knowledge sharing and dissemination ability. For example, the effect of knowledge transfer can be improved by perfecting the enterprise training mechanism and enhancing the training of technical knowledge.

Fourth, enterprises should give full play to the positive role of enterprise entrepreneurship orientation in promoting collaborative innovation activities. Entrepreneurship orientation is related to the strategic decision of the enterprise and reflects the operation process of the enterprise. After acquiring external knowledge and resources, enterprises can actively adopt the behaviors of innovative, risk-taking and proactiveness to promote the transformation of knowledge into performance. But at the same time, we should pay attention to the uncertainty of the external environment and the characteristics of the enterprise itself and choose the appropriate entrepreneurial orientation according to the actual situation of the enterprise. In addition, although this study does not find that there is an inverted u-shape relationship between external knowledge acquisition and knowledge sharing on enterprise performance, it does not mean that enterprises can acquire high intensity knowledge. This is because the ability of enterprises has ceilings in the short term. If we blindly pursue excessive knowledge, the enterprise is difficult to digest and absorb knowledge, and if the cooperative innovation ability of the enterprise also reaches the peak of this stage, at this time, the excessive external knowledge cannot improve the performance of the enterprise. Therefore, when adopting knowledge acquisition strategy, enterprises should select a balance point according to their own situation and their own ability.

7 RESEARCH SUMMARY AND PROSPECT

7.1 Summary of Research

Based on the theory of knowledge base, the theory of cooperation and the theory of organizational ambidexterity, this study takes the university science and technology park as the research object to explore the influence mechanism of knowledge transfer performance under the mode of collaborative innovation. There are three main innovations in this study:

First, from the perspective of research, the research of the university science and technology park is not mature. At present, most of the research focuses on the integration of resources, operation mechanism, the design of system and so on, but the research on the performance of knowledge transfer in university science and technology park is relatively few. From the perspective of knowledge collaborative innovation, this study discusses the relationship between external knowledge, collaborative innovation, entrepreneurship orientation, enterprise absorptive ability and knowledge transfer performance in university science and technology park.

Second, this study puts forward the theoretical model of knowledge transfer performance under the collaboration innovation mode of university science and technology park on the basis of considering the moderating effect of entrepreneurship orientation and absorptive capacity and the mediating role of collaborative innovation. In addition, through empirical analysis, this study examines the relationship between external knowledge, collaborative innovation, entrepreneurship orientation, enterprise absorptive capacity and knowledge transfer performance in university science and technology parks. It makes us can better understand the influence path of external knowledge on enterprise performance under collaborative innovation mode. It reveals the moderating effect of entrepreneurship orientation between collaborative innovation and knowledge transfer performance and the moderating effect of corporate absorptive capacity between external knowledge and collaborative innovation, and the mechanism of collaborative innovation activities between external knowledge and enterprise performance. This thesis finally put forward corresponding countermeasures and suggestions to improve the knowledge transfer performance of university science and technology parks.

Third, in terms of research methods, through qualitative analysis, combing the relevant theoretical literature, this study put forward the theoretical model. meanwhile, the quantitative analysis method is used to quantitatively analyze the data obtained by the investigation through the comprehensive use of SPSS and AMOS tool software, and the path influence relationship proposed by the research hypothesis above is tested. It can be seen that this study has both theoretical deduction and empirical analysis, qualitative and quantitative combination, and has some innovation in the research methods.

7.2 Prospects of Research

Knowledge transfer is a deep research field, due to the limitation of subjective and objective conditions, this study needs further study in depth and breadth. Therefore, the shortcomings and prospects of this study are as follows:

First, the research on the performance of knowledge transfer in university science and technology park is mainly verified by empirical research, and no aided explanation of cases is introduced. Relevant cases can be added to the subsequent study to make the study more persuasive.

second, this thesis uses cross-sectional data. we obtain the relationship between external knowledge, collaborative innovation, enterprise performance through the analysis of cross-sectional data, but the cross-sectional data can only reflect the state of the enterprise at a certain time, with the change of time, whether the variables still have the same influence relationship cannot be obtained in this study. Therefore, in the future research, time series research can be carried out to make the research conclusions more credible.

Third, 268 valid data were obtained in this study. Due to time resources and other constraints, it is not possible to obtain more representative samples by random sampling on a larger scale. Although the sample size meets the requirements of the study and ensures the credibility and validity of the conclusions to some extent, it is not large enough, and the statistical error exists, which will affect the accuracy and universality of the conclusions. The scope of the investigation can be expanded and obtain more credible conclusions.

Fourth, the research on university science and technology park focuses on the enterprises in the science and technology park, but the research on colleges and universities is insufficient, and the lack of investigation and interview on high schools leads to the

conclusion is not comprehensive. Therefore, the follow-up research needs to bring colleges and universities into the research object.

Finally, we only discuss the moderating effect of absorptive capacity and entrepreneurship orientation, but in the actual situation, the uncertainty of the external environment, the characteristics of both partners and government policies also have a great impact on knowledge transfer performance. Whether there are other variables to influence the path of knowledge transfer performance needs further study.

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APPENDIX 1

The Information summary of major university science and technology parks involved in the survey.

No	Name	Founded time	Number of enterprises	Description
1	Nige Hi-tech Development Park	1992	637	Located in Yong'an City, Fujian Province, it was turned to the national high tech Industrial Development Zone in February 2015.
2	Yongan graphite and graphene high tech Industrial Park	2017	53	Located in Sanming City, Fujian Province, the Park focuses on the graphene industry to drive and promote the implementation of a number of R & D projects and the transformation and upgrading of local enterprises
3	Yanxi Industrial Park	1995	30	Located in Yong'an City, Fujian Province, it is mainly an industrial high-tech enterprise
4	Sanming Puling Automobile Industrial Park	2013	63	Located in Sanming City, Fujian Province, it is one of the automobile professional parks in Fujian Province
5	Fuzhou high tech Industrial Development Park	1991	300	Located in Fuzhou City, Fujian Province, it is one of the first batch of national high-tech park approved by the State Council in 1991.
6	Shenzhen Nanshan Science Park	2001	700	Located in Shenzhen, Guangdong Province, it is a market-oriented national university science and technology park integrating high-tech R & D, incubation of high-tech enterprises, absorption and cultivation of innovative talents.

7	Zhuhai high tech industry open Park	1992	400	Located in Zhuhai City, Guangdong Province, it is a high-tech industrial park based on famous universities and integrating production, study and research.
8	Guangzhou International Biological Island Science and Technology Park	2000	200	Located in Guangzhou, Guangdong Province, it is the core carrier of Guangzhou National Bio Industry Base approved by the national development and Reform Commission.
9	Hangzhou Bay Information Port	2014	1575	Located in Hangzhou, Zhejiang Province, it aims to build an international first-class comprehensive green low-carbon environmental protection community integrating technology enterprise headquarters, technology project transfer, incubation, R & D, finance and business.
10	Nanjing Jiangning Development Zone Science Park	1992	500	Located in Nanjing, Jiangsu Province, it is a national economic and Technological Development Zone. It takes enterprise innovation as the main body, introduces 15 universities, and has more than 100 key laboratories and engineering technology R & D centers at or above the provincial and ministerial level.